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POPULATION DENSITY AND PUPIL TRANSPORTATION COSTS IN ALBERTA

by

MICHAEL SKUBA

A DISSERTATION

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a dissertation entitled "Population Density and Pupil Transportation Costs in Alberta" submitted by Michael Skuba in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

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ABSTRACT

The problem of this thesis was to determine the suitability of various measures of population "density" for the calculation of standardized costs of pupil transportation and for their inclusion in the Foundation Program in Alberta.

The data for the calculation of the numerical values of fourteen selected measures of density were obtained from 1961 operational reports.

The values of the fourteen measures were treated by a step-wise multiple regression analysis to determine their relationship to the costs of pupil transportation. Multiple regression equations were developed from the results and appraised in terms of applicability to each school division and county in Alberta.

The results of the study indicate that the five best predictor variables were: (1) pupil-district distance, (2) bus miles per statutory transported pupil, (3) bus miles per transported pupil, (4) statutory transported pupils per square mile of organized districts, and (5) statutory transported pupils per bus operated. The first three measures involved distance as one factor in the calculation; the fourth measure involved area as one factor in the calculation; and the fifth measure involved pupil load carried by buses. The measure, bus miles per square mile of organized districts, involving distance and area, but excluding number of pupils as a factor in the calculation was found to be the poorest predictor of pupil transportation costs when used in the procedures of the step-wise

selection of predictors.

Comparisons of several regression equations showed that the equation based on four of the best predictor variables was the most suitable to use in calculating standardized pupil transportation costs. Its use would result in discrepancies between calculated and actual costs of pupil transportation which were less than $10,000 in a maximum number of cases and in excess of $10,000 in a minimum number of cases. The use of this equation would provide for the lowest range of differences between standardized and actual costs of pupil transportation. Fifteen divisions or counties would require an additional mill rate, beyond Foundation Program requirements, to make up their deficiencies, but in only three cases would the additional levy be in excess of five mills.

The equation, based on the four best variables, was found to be comparatively simple to apply yet sufficiently comprehensive in its measurement of influences upon costs to account for eighty-six per cent of the variance between calculated and actual costs of pupil transportation in Alberta divisions and counties. The calculation of standardized costs of pupil transportation from this equation would be suitable for the inclusion of such costs in the Foundation Program in Alberta.

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CHAPTER I

INTRODUCTION TO THE STUDY

With the introduction of the foundation program in 1961, as a method of financing education in Alberta, the necessity of examining the means of determining the allowable costs of pupil transportation became apparent. A foundation program may be described, generally, as a plan for financing educational services in such a manner that there is an equitable distribution of the burden of cost between the provincial authority and the local units. According to the Alberta plan, 1961, taxable properties within the province were evaluated on an equalized assessment basis and a uniform mill rate for education was then levied. The sum of these property taxes and the provincial appropriations for education was distributed to the various school authorities according to a formula which determined shareable costs in each unit. Calculations of shareable costs were based on factors such as numbers and qualifications of teaching personnel, numbers of pupils educated, transportation costs, administration costs, and capital expenditures.

The particular purpose of this study arose from the inclusion of pupil transportation costs in the Foundation Program. Pupil transportation is a necessary element in the education of rural children if some degree of equalization of educational opportunity is to be realized. When the cost of providing pupil transportation services is included as one of the factors which determines the value of the foundation program

some technique becomes necessary for determining what the shareable costs will be. Whatever the method of calculating such costs, the amount of money recognized by the Foundation Program should be sufficient to maintain an adequate standard of transportation services in each division or county.

Subsequent to the introduction of the Foundation Program to Alberta in 1961 several successive approaches were used to calculate the amount of money to be included in the program for the support of pupil transportation. The approach used at the time this study commenced was based upon an assumed relationship between a certain measure of density of population and the resultant cost of pupil transportation services.

The Purpose of This Study

The general purpose of this study was to determine the influence of numbers and geographic distribution of pupils conveyed to Alberta schools upon the costs of the resultant transportation services. More specifically, the purpose was to determine the suitability of various measures of population "density" as predictors of pupil transportation costs in Alberta school divisions and counties.

The significance of the study is related to the continuous growth of transportation services in Alberta and to the introduction of the foundation program as a means of financing the public schools. The remainder of this chapter will be devoted, therefore, to:

1. documenting the continuous growth and cost of pupil transportation services in Alberta and stating the chief causes thereof;

2. tracing changes prior to 1961 in respect of the system of distributing provincial funds to public schools in Alberta and, in particular, in respect of aid to pupil transportation;
3. setting forth the concept of the foundation program and its particular application to pupil transportation in Alberta;
4. establishing the necessity for including pupil transportation costs in the foundation program and establishing the general approach to their treatment; and finally
5. restating the purpose or problem of this study in relation to the information set forth above.

GROWTH OF PUPIL TRANSPORTATION

Prior to 1910 pupil transportation services, on a very limited scale, were provided mostly by parents. The legal requirement that school boards convey children between home and school emerged in Alberta in the following decade when a number of consolidated school districts were established. Pupil transportation at public expense, may, therefore, be considered as one of the relatively recent services which school authorities in the province have undertaken to provide.

Factors Associated with Growth of Pupil Transportation

Both the scope and the cost of pupil transportation services were relatively minor in relation to total educational services and costs until two incidents occurred: the enactment of provincial

legislation in 1935 making provisions for the establishment of school divisions and the outbreak of World War II in 1939.

Coincident with these two major events and other developments of the post-war period were the following forces and movements:

(1) The decline of a pioneer concept of education and the rise of a desire to provide improved opportunity to children of urban, semi-urban, and rural areas alike;

(2) Enlargement of the geographic unit used for local administration and financing of public education;

(3) Extension of the boundaries of school attendance areas and the resultant larger schools;

(4) Popularization of secondary education;

(5) Development of good roads and highways;

(6) Increasingly widespread use of motor vehicles by all classes of the population and the increased mobility of population;

(7) Increased confidence in the comfort and safety of vehicles used to transport pupils;

(8) Legislation that increased financial support for pupil transportation;

(9) Rapid increase of school population following World War II;

(10) Efforts of the government to solve the problem of over-colonization of submarginal lands;

(11) The tendency for wealth to concentrate personally and geographically; and

(12) Industrialization, urbanization, and the whole social movement for the improvement of rural life.

The Scope of Pupil Transportation Services

As one consequence of these developments, the growth of pupil transportation in the last quarter century has been phenomenal. During the period 1940 to 1947 inclusive, the total cost of pupil transportation in Alberta increased by approximately 440 per cent.[1] Since that time, the enterprise has continued to grow until presently only a few school systems do not offer extensive pupil transportation service. In 1960, almost 85,000 pupils were transported for a daily total bus mileage of 150,000 miles in 2,500 vehicles at an annual cost of nearly $9,000,000.[2] Transportation service was extended to approximately sixty-seven per cent of all pupils in rural areas or more than one-fourth of all pupils attending public and separate schools in Alberta. Provincially, the cost of pupil transportation in the same year was of magnitude second only to that of teachers' salaries. It accounted for almost twenty per cent of the total expenditures for education in divisions and counties.

Growth of pupil transportation services reflected changes in school operation in the province. After the formation of Alberta as a province, and until the 1940-41 school year, there had been a continuous

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[1] G. L. Mowat, A Plan For Recognizing Pupil Transportation Costs in the Province of Alberta for Purposes of Equalizing Educational Opportunity. Unpublished Dissertation, Stanford University, 1953.

[2] Department of Education, Province of Alberta, Fifty-fifth Annual Report, 1960.

increase in the number of organized school districts which operated schools. However, as larger administrative units and the effects of World War II with its teacher shortage began to have impact on centralization, many one-room rural schools were closed and the pupils conveyed to larger multi-grade schools. In the 1961-62 school year, consequently, although there were 11,285 classrooms in operation in 1,416 districts, only 203 one-room schools remained in operation.[3]

The above changes in school operation brought increased expenditures on pupil transportation services. Table I illustrates the resultant growth of pupil transportation between 1936 and 1961. It shows for each year the total daily run of school buses in miles, the number of pupils transported daily, the annual operating expense, and the number of buses in operation. Although the complete data were not available for the earlier years, it was evident that the scope of the service must have been very limited prior to 1938. The annual operating expense was of such little significance that it had been included in "miscellaneous expense" of school boards in annual reports. Of particular interest to this study was the general increase in each of the following aspects of pupil transportation services.

Total Daily Run in Miles. During the period 1947 to 1960 inclusive, the total daily run in miles increased from 29,718 to 151,482 miles. These figures represent an increase of almost 510 per

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[3]Department of Education, Province of Alberta, Fifty-seventh Annual Report, p. 193.

TABLE I

ANNUAL DATA ON BUS OPERATIONS IN ALBERTA

1936 - 1961*

Year	Total Daily run in miles	No. Pupils trans. daily	Annual Operating expense	Number of Buses		
				Contract	Public	Total
1936	x	x	x	x	x	x
1937	x	x	x	x	x	x
1938	x	x	$ 157,689	x	x	x
1939	x	x	215,825	x	x	x
1940	x	x	272,601	x	x	x
1941	x	x	242,468	x	x	x
1942	x	x	359,924	x	x	x
1943	x	x	423,766	x	x	x
1944	x	x	604,206	x	x	x
1945	x	x	793,036	x	x	x
1946	x	x	953,000	x	x	x
1947	29,718	15,787	1,091,003	559	138	697
1948	39,972	20,026	1,441,080	631	169	800
1949	42,180	25,380	1,881,517	698	274	972
1950	53,933	32,499	2,377,571	860	296	1,156
1951	59,411	36,368	2,809,211	903	341	1,244
1952	76,510	43,243	3,563,345	1,077	410	1,487
1953	77,370	49,372	4,268,582	1,145	474	1,619
1954	83,973	54,453	5,161,085	1,142	607	1,749
1955	102,790	62,684	5,789,812	1,350	671	2,021
1956	113,056	66,823	6,478,981	1,436	718	2,154
1957	126,890	70,973	7,065,711	1,459	824	2,283
1958	135,745	74,516	7,735,805	1,492	887	2,379
1959	143,141	79,287	8,322,420	1,491	955	2,446
1960	151,482	83,488	8,853,972	1,508	1,009	2,517
1961	151,454	83,625	10,001,476	x	x	2,522

* Department of Education, Province of Alberta, Annual Reports, 1936-1961 inclusive.

x Indicates no data available.

cent in the number of miles travelled daily by school buses. They indicate that on the average almost 10,000 miles of bus route were added each year during this period.

Number of Pupils Transported Daily. During the same period the number of pupils transported daily increased from 15,787 to 83,488. These figures indicate an increase of nearly 530 per cent in the number of pupils transported to school by bus. They show that on the average more than 5,000 additional pupils were transported each year during this period.

Annual Operating Expense. The increase in the annual operating expense for pupil transportation during the period 1947 to 1960 was even more spectacular. It increased from $1,091,003 to $8,853,972. These figures represent an increase in excess of 810 per cent. They indicate that the average increase in expenditure each year was more than $600,000. During this period the annual cost per pupil increased from $69 to $106. The average annual cost per mile travelled increased from $37 to $58 during the same time.

Number of Buses. The number of buses in operation during the period 1947 to 1960 increased from 697 to 2,517. These figures represent an increase of over 360 per cent in the number of buses used to convey pupils to school. They indicate that on the average approximately 150 additional buses were operated each year during this period.

In general, during the period 1947 to 1960 the rates of increase varied among the mileage travelled daily by buses, the number of pupils

transported daily, the annual costs of operation, and the number of buses operated in the divisions and counties of Alberta. The overall growth of pupil transportation services, however, was continuous. These trends are illustrated in Figure I.

It is unlikely that the number of pupils requiring transportation will increase substantially in future years because of the declining farm population[4] and because centralization of schools is already well advanced. It appears likely, however, that there will be little, if any, relief in the steep upward trend in the financial burden arising from pupil transportation costs. Increasing requests are being made on school systems to provide "gate service" to children although this is not a requirement of the School Act. It is also possible, and even likely, that centralization of school services which affected elementary schools during the 1940's and 1950's will become increasingly important at the secondary level during the 1960's.

CHANGES IN PROVINCIAL GRANT SYSTEM

In recognition of the importance and growth of pupil transportation in Alberta, the Department of Education has always provided some forms of grants for education. In the early periods of Alberta's history pupil transportation grants were described as "grants in aid

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[4]See Harold J. Ulhman, Rural Alberta: Patterns of Change, Monographs in Education No. 5 (Edmonton: The Alberta Advisory Committee of Educational Research, University of Alberta, 1961).

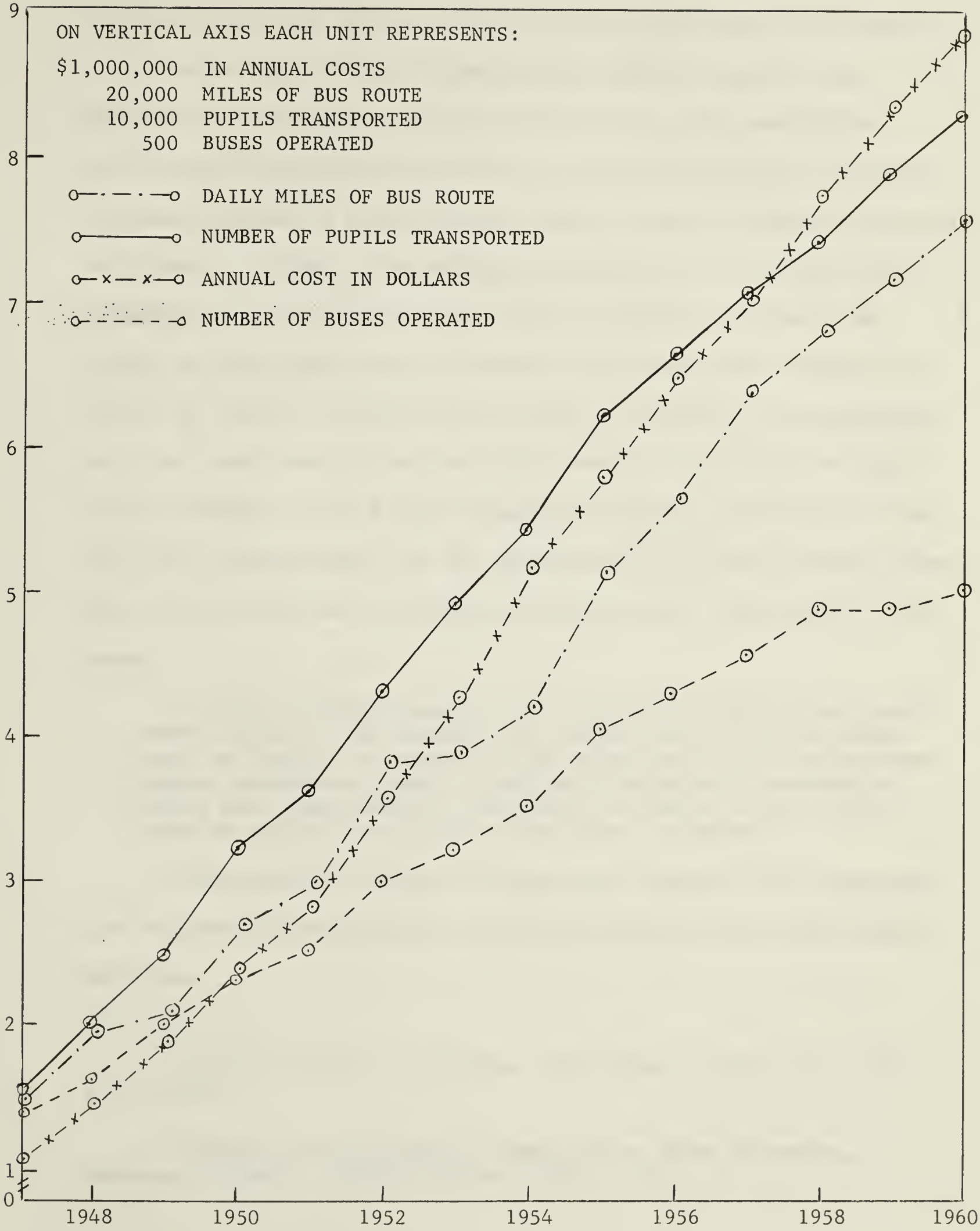

FIGURE I

THE GROWTH OF PUPIL TRANSPORTATION IN ALBERTA

of rural education" and as "grants in aid of consolidated districts."[5]

Later grant schemes emphasized the need for equalization. These schemes attempted to compensate districts with insufficient basic wealth assessable for purposes of financing education. The new emphasis represented a step toward a basic program in the rural schools of Alberta. Although these schemes of provincial aid to local units of administration recognized variations in ability to support the burden of educational costs, there were indications that serious disparity of financial ability still existed. As general dissatisfaction with the conditions of rural education continued, in 1934, the Legislative Assembly of the Province appointed a special committee to study and make recommendations for the improvement of the rural school system. The special committee, reporting to the provincial legislature in 1935, said:

> The most striking feature of the financial aspect of our rural school system is the anomaly that, while each district is under legal obligation to provide for the education of all the children within its borders, there is such wide variation in assessable wealth that some districts are forced to levy at a rate twenty times as high as that which is sufficient to others.[6]

Subsequently, in 1935, the government commenced the reorganization of rural districts into large administrative units called School Divisions.

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[5]Revised Statutes of Alberta, "The School Grants Act," c.59, s.2, (1926).

[6]Report of the Legislative Committee on Rural Education, Edmonton, Alberta: King's Printer, 1935, p. 23.

Revisions of the Grants Act and subsequent series of orders-in-council provided further evidence of policies designed to equalize educational opportunities and the costs of education. Although periodic revisions and improvements in grant structure were made as time went on, the basic provisions of support for education remained relatively unchanged until the introduction of the Foundation Program in 1961.

Aid For Pupil Transportation

Prior to the creation of school divisions in Alberta, the most common larger units of administration were the consolidated school districts. Boards of such districts were responsible for transportation services within their member-districts. The cost of these services constituted the major portion of such expenses in the province. As the transportation of pupils developed in scope following the formation of school divisions and as it became established as a service essential to the school systems of the province, the expenses incurred began to assume proportions which called for increased provincial aid and for revised regulations concerning such aid.

In the period prior to 1943, school divisions could make payments of public funds for pupil transportation services under authority of legislation pertaining to Consolidated Schools. In 1943, an amendment to the School Grants Act made specific references to school divisions:

> Where it is deemed necessary by the divisional board to make provisions for the attendance of pupils at schools outside the district where the parents or lawful guardians reside, the board

> shall provide conveyance for the children to and from school, if the nearest boundary of the quarter section on which they reside is more than three miles from the school site and more than one and one-half miles distant by the nearest travelled route from a regular conveyance route; or the board may at its option and subject to the approval of the Minister, enter into an agreement with the parents or guardians to provide their own conveyance, and shall pay therefore a sum not exceeding twenty-five cents a mile per family per day for every mile actually travelled between the nearest boundary of the quarter section on which the family resides and the school or conveyance route, as the case may be, but it shall not pay more than one dollar per day to the parents or guardians of any one family.
>
> Providing that where the board and the parents or guardians cannot agree on the proper amount to be paid for providing conveyance, the matter shall be referred by the board to the Minister, who shall fix an amount which he deems adequate for the cost of conveyance, and his decision shall be final.[7]

This amendment established the responsibility of the boards of school divisions with respect to the transportation of pupils from districts in which the schools were closed. It also gave the board an option, where transportation was not feasible, of providing payment in lieu of transportation.

By 1947, there were two main types of grants under which pupil transportation earned provincial support. The first was based on the round-trip distance travelled by buses which carried an average daily load of eight pupils. In the event that the average daily load was less than eight pupils, a proportionate grant was paid.[8]

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[7]Statutes of Alberta, "The School Grants Act," c.47, s.6, 1945.

[8]Revised Statutes of Alberta, "The School Grants Act," c.177, s.4, 1947.

The second schedule of grants in which pupil transportation was considered was as follows:

> 4. There shall be paid to each district or division a grant based on the number of rooms and the equalized assessed valuation of the district or division, in the following manner:
> (a) The number of rooms to be used in the calculation of this grant shall be the number of operating rooms, to which shall be added rooms or fractions of rooms as follows:
> (i) For each district from which an average of 5 or more pupils are transported to a graded school _____ .25 rooms. In the event that the average is less than 5, for each pupil so conveyed _____ .04 rooms;
> (ii) For each pupil conveyed more than 2½ miles but not more than 6 miles _____ .02 rooms;
> (iii) For each pupil conveyed more than 6 miles but not more than 12 miles _____ .03 rooms;
> (iv) For each pupil conveyed more than 12 miles _____ .04 rooms;
> (v) For each supervisor of instruction _____ 1 room;
> (vi) For each vocational teacher not otherwise included _____ 1 room.[9]

Prior to this provision, as centralization occurred and the number of classrooms operated by each division tended to decrease, the equalization grant of divisions dropped accordingly. The intent of the section was to remedy this condition and provide further stimulation toward centralization. The annual report of the Director of School Administration stated:

> To prevent the centralization of schools having an adverse effect upon equalization grants, the schools which are closed and the pupils conveyed to a central school are counted as fractions of operating rooms in these computations.[10]

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[9] Revised Statutes of Alberta, Regulations Relating to the Payment of Grants, c.177, 1947.

[10] Department of Education, Province of Alberta, Forty-first Annual Report, 1946, p. 45.

Further modifications and changes in the grant regulations affecting pupil transportation were made after 1947 in the amount of grant and in the administrative detail associated with it, but the basic type of pupil transportation grant remained unchanged until the introduction of the Foundation Program.

THE FOUNDATION PROGRAM CONCEPT

In 1961, in a further effort to assure reasonably adequate educational opportunities and reasonably comparable financial efforts in all communities, provincial authorities turned to a foundation program concept of educational finance.

Definition of a Foundation Program

In theory, the term "foundation program" implies the provision and suitable financing of a basic or more-than-basic educational program. In practice, the foundation program is likely to be introduced only as a particular means of financing educational programs already in existence. In any case, the essential characteristics of the foundation program are:

(1) the establishment or acceptance of services which all local authorities are expected to offer and the translation of these services into costs;

(2) the establishment of a uniform rate of local contribution to the foundation program fund as calculated in (1) above;

(3) the contribution by the province of funds equal to the difference

between the value of the foundation program as calculated in (1) above and the amount obtained from a uniform rate of contribution as indicated in (2) above.

Origin of the Concept

The foundation program concept evolved in the United States during the 1920's. It was introduced and interpreted in the Educational Finance Inquiry in New York in 1923. The basic elements of the concept as stated by Strayer and Haig were:

> To carry into effect the principle of "equalization of educational opportunity" and "equalization of school support", as commonly understood, it would be necessary (1) to establish schools or make arrangements sufficient to furnish the children in every locality within the state with equal educational opportunity up to some prescribed minimum; (2) to raise the funds necessary for this purpose by local or state taxation adjusted in some manner as to bear upon the people in all localities at the same rate in relation to their taxpaying ability; and (3) to provide adequately either for the supervision and control of the schools, or for their direct administration, by a state department of education.[11]

It was pointed out that the simplest method of financing schools to achieve equalization of educational opportunity and local financial effort would be to introduce a system of uniform state-wide taxes. After commenting on the difficulty of centralizing taxation and developing a suitable revenue system, Strayer and Haig concluded that it would be desirable to enquire into the measure of responsibility for financial support that should be left to the local area.

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[11]George D. Strayer and Robert M. Haig, The Financing of Education in the State of New York, Report of the Educational Finance Inquiry Commission (New York: The MacMillan Company, 1923), p. 173.

Their subsequent statement of the foundation program concept presented a new approach in educational finance. It constituted the background for studies and developments that have revolutionized provisions for financing schools.

The Foundation Program in Alberta

In 1961, the Alberta Legislature passed an act to set up a Foundation Program Fund for education. This fund was made up from a uniform contribution of 32 mills on equalized assessment of taxable properties in the province plus a contribution from provincial appropriations. The money from this fund was then distributed to the various school authorities according to their respective needs as computed on the basis of six items: (1) Instruction -- pupils and teachers; (2) Maintenance of school plant; (3) Instructional aids; (4) Transportation and maintenance of pupils; (5) Administration; and (6) Capital expenditures.

The cost of pupil transportation was one of the items on which the value of the Foundation Program was calculated. In the first two years of the Foundation Program, two different methods were used to include the cost of pupil transportation. In 1961 the formula incorporated a modified "dwelling-to-school" distance factor and in 1962 it was based on a "density of population" factor.

Pupil Transportation Regulations: 1961. The regulations governing the calculation of payments for pupil transportation read:

Part D - Transportation and Maintenance of Pupils.

1. From one district to another.
   (a) For the purpose of this section, district means a divisional district, or in the case of a consolidated district a component school district of such consolidated district. It shall include also any non-divisional district, pupils resident in which are transported to a school in another district, payment being claimed by the district or division actually providing the transportation.
   (b) For each district there shall be determined a distance to the nearest half-mile, between the school to which children from that district are transported and the most distant point in that district from the school. The distance shall be computed by proceeding directly North or South, or East or West, as the case may be, from the most distant point of the district, to a point directly East or West, or North or South, of the school site, and proceeding to the school site.
   (c) The lines determined in (b) need not be upon road allowances.
   (d) From the distance for each district computed as above there shall be deducted 1.5 miles, the result being termed the "district distance".
   (e) The number of pupils transported from each district shall be counted on February 15, May 15, September 15, and November 15, and the number of pupils being transported for the purpose of computing the amount of entitlement in respect of transportation of pupils for the quarter year in which the date falls.
   (f) If a parent or guardian is paid an allowance in lieu of conveyance for conveying his own child or children, such child or children shall be deemed to be transported from the district in which they are resident; provided, however, that if the transportation is to a bus route, the child or children shall only be counted in respect of clause (e).
   (g) Pupils who are transported regularly from one school to another to take classes in home economics, industrial arts, or other courses acceptable to the Department, shall be counted for the purpose of this part, the "district distance" being that between the two school sites, computed as in (b) above, but each pupil shall be deemed to be such fraction of a pupil as the number of return trips

per week applicable to him bears to five.

(h) The amount payable in respect of each pupil, annually, shall be the district distance applicable to him multiplied by the sum of eleven dollars ($11.00).

2. Within a district.
Each pupil resident within the district in which the school he attends is situated, who is transported to school in a bus regularly operated by a division or for whom an allowance in lieu of conveyance is paid, shall be counted and the "district distance" shall be deemed to be one and one-half miles (1.5). The amount payable to the division shall be computed in the same manner as in 1.(h) above.

2a. (1) Notwithstanding section 2 of this part if a non-divisional district provides transportation for pupils within the district, whether by bus or otherwise, it shall be entitled to receive the actual cost of providing such transportation, upon certification by the Minister that the service was necessary and the cost reasonable.

(2) Advances, not to exceed 25% of the amount included in the 1961 budget of the district, may be paid quarterly to the district, subject to adjustment at the end of the year.

3. Boarding Allowances.
For each pupil for whom the division pays a boarding allowance it shall be paid one dollar ($1.00) per day for each day for which such allowance is paid.
If the division operates a dormitory the sum of $1.00 per day provided herein may be paid directly the division in respect of pupils whose parents are residents of the division.[12]

The calculation of pupil transportation costs was based on a formula which used the product of the total number of pupils transported from all districts of a division or county and a modified "dwelling-to-school" distance for each district to adjust the basic

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[12]Department of Education, Province of Alberta, Order-in-Council No. 650/61, 1112/61, and 1131/61.

annual rate of eleven dollars ($11.00) per pupil. This method of calculating pupil transportation costs involved a considerable amount of detail regarding the location of residence of pupils living within a division or county.

Pupil Transportation Regulations: 1962. In 1962, the formula for determining the amount payable for pupil transportation was changed substantially. The regulations read:

> Part D - Transportation and Maintenance of Pupils.
>
> 1. Within school divisions, counties, consolidated school districts other than city districts:
>
> (a) The total area, in acres, of the organized school districts contained therein shall be determined.
>
> (b) The total number of pupils transported, or for whom an allowance in lieu of transportation is paid, or for whom a boarding allowance is paid, shall be counted, except that each pupil who resides within 1½ miles of the school, as defined in Section 313 of the School Act, which he or she attends shall not be counted, and each pupil who is transported regularly from one school to another to take classes in home economics, industrial arts, or other courses acceptable to the Department, shall be counted for this purpose, but each such pupil shall be deemed to be such fraction of a pupil as the number of return trips applicable to him bears to five.
>
> (c) The number of acres as determined pursuant to (a) shall be divided by the number of pupils pursuant to (b) and the division, county, consolidated school district or school districts other than a city district shall receive, subject to (d) hereof, in respect of each pupil the sum provided in the table following.
>
> (d) The actual expenditure for transportation and maintenance of pupils shall be determined for the year 1961, exclusive of the cost of the purchase of buses but inclusive of the sum of $850 for each bus having a seating capacity of 30 pupils or more, and of $700 if having a seating capacity of 29 pupils or fewer, for each bus owned and regularly

operated by the board, and similar amounts for each spare bus, not to exceed one such bus for each ten buses operated, but the allowance for each such bus shall terminate 8 years after the date of its manufacture. The sum so determined shall be divided by the average number of pupils transported in 1961, exclusive of pupils residing within 1½ miles of the school attended and the result multiplied by the average number of pupils transported in 1962 as determined under 1 (b).

i. If the amount determined under (c) exceeds the amount computed under (d) the latter amount shall be paid.

ii. If the amount computed under (c) is less than the amount computed under (d) then 90% of the amount of (d) or the amount of (c) shall be paid, whichever is the greater.

2. Within city school districts.

(a) If bus service is provided in buses operated for the purpose of transporting pupils, whether in buses owned by the district, or contracted for with private or public carriers, there shall be paid the sum of $95 per pupil transported, exclusive of pupils who reside within 1½ miles of the school attended, measured along roads or streets accessible to such pupils.

(b) If the amount determined under (a) exceeds the actual cost of transportation then the latter amount shall be paid.

(c) If the amount computed under (a) is less than the actual cost of transportation then 90% of the actual cost, or the amount of (a) shall be paid, whichever is greater.

(d) If regularly operated public carriers are used, the district shall be reimbursed to the extent of 90% of its actual expenditures.

3. The Minister may:

(a) declare any district to be a city district for the purpose of this part;

(b) make such provisions for cases not covered by these regulations as appear to him just and equitable.

4. Dormitories.

If a division operates a dormitory, the sum of $1.00 per day may be paid directly to the division

in respect of pupils whose parents are residents of the division.[13]

The Table referred to in section 1(c) of the regulations was:

Acres per pupil	Amount per pupil	Acres per pupil	Amount per pupil
1 to 40	$ 95.00	721 to 760	$ 131.00
41 to 80	96.00	761 to 800	134.00
81 to 120	98.00	801 to 840	137.00
121 to 160	99.00	841 to 880	140.00
161 to 200	101.00	881 to 920	143.00
201 to 240	103.00	921 to 960	147.00
241 to 280	105.00	961 to 1000	150.00
281 to 320	106.00	1001 to 1040	154.00
321 to 360	108.00	1041 to 1080	158.00
361 to 400	110.00	1081 to 1120	162.00
401 to 440	112.00	1121 to 1160	167.00
441 to 480	114.00	1161 to 1200	171.00
481 to 520	116.00	1201 to 1240	176.00
521 to 560	119.00	1241 to 1280	181.00
561 to 600	121.00	1281 to 1320	187.00
601 to 640	123.00	1321 to 1360	193.00
641 to 680	126.00	1361 to 1400	199.00
681 to 720	128.00	1401 to 1440	206.00[14]

The 1962 pupil transportation costs were calculated by using a "density of population" factor as a basis for determining the annual amount payable per pupil. Density was calculated from the number of acres of organized districts in a division or county and the number of pupils who lived beyond one and one-half miles from

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[13]Department of Education, Province of Alberta, Order-in-Council No. 546/62.

[14]Ibid.

the school they were directed to attend. Corresponding to a classification of density groups based upon the number of acres per pupil, an amount per pupil was established for each of the thirty-six density groups, varying from $95.00 to $206.00 per pupil. Calculations of the total shareable costs were relatively simple. The number of pupils requiring transportation was multiplied by the amount per pupil applicable to the particular density group to determine the annual payment to any division or county.

PUPIL TRANSPORTATION IN A FOUNDATION PROGRAM

The foregoing review of the regulations pertaining to pupil transportation for the first two years of operation of the Foundation Program in Alberta supports several conclusions. First, the intent was to provide for the inclusion of pupil transportation costs in the calculation of the value of the foundation program. Second, a separate means of treating pupil transportation costs, apart from instructional or other costs, was adopted. Third, the means of treating pupil transportation costs was based upon some expression of "density of population" rather than upon actual expenditures.

The pupil transportation regulations of 1961 and 1962 both contained these three characteristics. The need to determine the validity of this general approach to the financing of pupil transportation costs in the school systems of the province does, in a sense, illustrate the need for this study.

This section will, therefore, provide a brief indication that the provisions of the Alberta Foundation Programs in 1961 and 1962 which related to pupil transportation were basically defensible.

The Inclusion of Pupil Transportation Costs in a Foundation Program

There are several reasons why pupil transportation costs should be included as part of a foundation program plan. Johns and Morphet, writing in support of the inclusion of pupil transportation costs, stated:

> In the first place the total cost of the foundation program is financed from state and local funds, whereas, if transportation is financed separately, the funds obviously must come from state sources. In the latter case there seems to be some danger that undesirable state controls may be imposed in an effort to hold down costs. In the second place, when transportation funds are separate they must be used entirely for transportation, whereas,if they are included in the foundation program any portion not used for pupil transportation can be used by the local school system for other aspects of the educational program.[15]

The objectives of the foundation program suggest an even more fundamental reason for including transportation costs. In densely populated areas where children live within walking distance of the schools, no extra costs are involved for transportation of pupils to school. In less densely populated areas such as most divisions, counties, and rural districts, however, major expenditures are frequently required to bring pupils to school. Such expenditures

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[15] Roe L. Johns, and Edgar L. Morphet, Financing the Public Schools, (New Jersey: Prentice Hall, Inc., 1960), pp. 350.

must be paid in toto by the province or included in the foundation program or the consequences will be extra financial burden within the jurisdiction where pupil transportation is necessary. Such costs must be recognized in a foundation program if the objectives of implementing acceptable basic programs with equal local effort are to be achieved.

Separate Measures of Pupil Transportation Need

Granting the inclusion of pupil transportation costs in a foundation program there are at least two major procedures which should be considered in determining the basis for such inclusion. One approach is to determine transportation costs on a basis different from that used in determining other costs, such as instruction; the other, is to develop a single measure of need to be used for all aspects of the foundation program, including pupil transportation. Whichever procedure is followed, the first step would be to establish objective, equitable, and valid measures of educational need.

While there is agreement among many writers that sound measures of need must be developed there are differences of opinion whether a single measure should be used for determining all the aspects of educational need.

Theoretically, a single measure for determining all the aspects of need might be defensible. Mort originally proposed the derivation and use of a single all-encompassing unit. Studies had been made to determine the feasibility of using such a unit. On the

basis of these studies a single unit of measurement had been explored.[16] Unless carefully developed, however, the single unit could serve either to retard further centralization because insufficient allowances might be made to cover the costs of transportation or, under different circumstances, it might unduly stimulate a high degree of centralization.

Furthermore, pupil transportation costs, unlike instructional costs, are not directly related to the number of classrooms, pupils, or teachers. The costs of pupil transportation are affected by such elements as: (1) the number of pupils who live more than a prescribed distance from the school they are directed to attend; (2) the distribution of the pupils within the jurisdiction wherein pupil transportation services must be provided; (3) the type of school organization employed; and (4) the road conditions and topography of the area concerned.

Generally, evidence seems to support the necessity of using a separate measure or measures for determining pupil transportation need apart from the measures used to determine instructional need. Furthermore, simple factors such as numbers of pupils requiring transportation, or total miles travelled by buses cannot be considered as adequately accounting for the variations which exist in the

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[16] See for example, William P. McLure, Effect of Sparsity on School Costs, Contributions to Education No. 929, (New York: Bureau of Publications, Teachers College, Columbia University, 1947).

costs of pupil transportation in the divisions and counties of Alberta. Therefore, there is a necessity to find complex measures of need for pupil transportation which are related to the four elements mentioned above. The studies on pupil transportation, reported in summary in Chapter II, will indicate variables affecting the costs of providing pupil transportation services. The use of density measures derived from the variables will be outlined and those that seem most applicable to the situation in Alberta will be selected for further treatment in this study.

The Treatment of Transportation Costs

Determination of costs of pupil transportation to be included in a foundation program calls for accurate techniques for computing the amount of money required by each local school system to provide those services. Thus the extent that the estimates of costs vary from the expenditures, corresponding discrepancies will cause variations from the uniform local tax effort sought through the foundation program.

There are several possible approaches to the recognition of pupil transportation costs. One extreme would be to remove the costs from the jurisdiction of school authorities. This action would result in a provincially operated and controlled pupil transportation system. The other extreme would be to accept locally incurred costs *per se* and to include them, on a reimbursement basis, in the foundation program. Both extremes have their limitations.

The former might have a tendency to deaden local interest and initiative; the latter might tend to perpetuate undesirable and uneconomical practices. In other words, the latter would encourage fiscal irresponsibility while the former would fail to recognize tradition.

At some point along the continuum between a provincially operated pupil transportation system and a locally operated system lies a "middle position" which encourages fiscal responsibility and promotes local initiative. This "middle position" might utilize procedures whereby schedules of costs are standardized and based upon factors largely beyond the control of school boards. Such factors are frequently related to numbers, density, and distribution of population. The literature reported in Chapter II indicates that such approaches have been accepted as being suited to the inclusion of pupil transportation costs in foundation programs.

SUMMARY AND RE-STATEMENT OF PROBLEM

The purpose of this study was to determine the suitability of various measures of "population density" as predictors of pupil transportation costs in Alberta school divisions and counties.

The growth of pupil transportation services, both in scope and in expenditures, has been related to the factors contributing to such growth and to the changes in school operation over the past twenty-five years.

Changes in the provincial grant system, particularly relating to pupil transportation, show the continuous attempts made to cope with the expansion of pupil transportation services in the province. The attempts made in the 1961 and 1962 pupil transportation regulations of the Alberta Foundation Program were illustrated.

The discussion indicates that pupil transportation should be included as one of the items in any sound foundation program plan if any degree of equalization of educational opportunity and of its financial support is to be achieved. Apparently, neither a provincially operated and controlled pupil transportation system nor the inclusion of locally incurred costs *per se* would be a desirable approach. Therefore, some methods of predicting standardized costs based on current operational data seem necessary. The calculation of standardized costs, it was noted, should be based on one or more measures, apart from the measures used for calculating instructional costs. When the costs of providing adequate pupil transportation services have been predicted as accurately as possible, they should then be included in the Foundation Program.

In a study of equalization of educational opportunity, which was limited to equalization of instructional costs, Reeves stated ... "the plan presented can be readily adopted to include the transportation need of any district. All that is required is a

valid index of transportation need."[17] Although this statement has been taken from a study conducted in 1948, and various attempts have been made to improve the measurement of need, a new approach has become necessary because of the changed method of financing educational costs in Alberta.

This study will, therefore, attempt to achieve the following four main objectives:

1. To review the pertinent literature for the purpose of selecting and developing several density measures to be used in the study;
2. To derive the numerical values of the measures from 1961 operational data and test the suitability of the calculated measures by determining their relationships to the costs of pupil transportation;
3. To apply the results obtained from the statistical procedures by developing multiple regression equations and by appraising the equations in terms of applicability to each school division and county; and
4. To summarize the findings and illustrate the most suitable equation to use in providing an adequate and equitable basis for computing standardized costs of pupil transportation for inclusion in the Foundation Program in Alberta.

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[17] A. W. Reeves, Equalization of Educational Opportunity in the Province of Alberta. (Unpublished Ed.D. Thesis, Stanford University, 1948,), pp. 135-136.

CHAPTER II

STUDIES OF FINANCING PUPIL TRANSPORTATION SERVICES

One of the objectives of this study mentioned in the preceding chapter was to review the relevant literature for the purpose of selecting the factors that might have significant relationships to pupil transportation costs in Alberta. This chapter, therefore, will provide the background for the general problem of computing recognized pupil transportation costs using a variety of measures of density. It will proceed with (1) a review of the selected literature pertaining to nine pertinent studies on pupil transportation with major emphasis on the types of factors, indicators, or measures used for predicting need for pupil transportation, (2) a brief summary of procedures used in four regions of the United States for the inclusion of these measures of pupil transportation need into a foundation program, (3) a discussion of those measures most closely related to costs of pupil transportation, and (4) a selection and development of measures to be used in this study.

REVIEW OF SELECTED STUDIES

The literature which reports the research into the problems of pupil transportation is quite extensive. A sufficient amount of the related literature will be cited to indicate trends in the use of density measures in determining pupil transportation costs and to

illustrate some of the ways in which such costs have been incorporated in foundation programs.

The majority of studies of this problem have indicated that adequate state aid programs have been based on factors which take into account the numbers of pupils requiring transportation, the area served by a transportation system, the distances over which pupils must be transported, and other factors such as school organization, topography, and road conditions, which are considered to be beyond the control of local school authorities.

In general, the studies that have been done on pupil transportation have been designed:

1. to develop units of cost;
2. to compare costs in different school systems;
3. to identify and measure factors which influence costs;
4. to develop methods for estimating the probable costs in a school system; and
5. to develop techniques for evaluating various methods of allocating state aid.

Mort's Studies

Mort judged pupil transportation to be a necessary but secondary educational cost. Accordingly, he divided educational costs into two categories: (1) those arising from aspects of the educational enterprise which are common to all communities, and

(2) special provisions, such as transportation, not common to all communities.[18] He felt that the teacher or classroom unit by itself would not suffice for the determination of transportation costs. While in his early studies he did not devise a new unit, he recognized the need for doing so. In his later study of costs in New York State he used density, defined as units of population divided by area or acreage of land, as a measure of the density of school population. At the same time he originated the suggestion of measuring the need for pupil transportation in terms of density of population. In his New Jersey study he used three elements in computing need: (1) the number of pupils transported, (2) the distances covered by the transporting vehicles, and (3) the size of the vehicles. As a theoretical basis for computing pupil transportation costs he favored using the density of school population factor.[19]

Burns' Studies

Burns accepted Mort's designation of transportation as a special provision not required of all school systems and used correlation techniques as employed by Mort. He designated "percentage of pupils transported" as a dependent variable and sought to find

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[18] See Paul R. Mort, State Support for Public Education, (Washington, The American Council on Education, 1933).

[19] See Asael C. Lambert, School Transportation, (Stanford, Stanford University Press, 1938), p. 67.

an independent variable which would relate closely to it. The independent variable was found to be "density of total population." By relating density of total population to the percentage of pupils transported (by means of a rank order formula) he concluded that there was a close relationship between density of population and transportation costs. Later he further refined his formula by using density of school population instead of density of total population. Although Burns considered other factors, he concluded that "there was so close a relationship between density of school population and need of transportation that a state could predict need for pupil transportation on this basis."[20]

Johns' Studies

Johns accepted the proposition that some independent variable could be used to predict the need (cost) for school transportation. He attempted to fit pupil transportation costs into a plan for state aid without disturbing the primary measure based upon "typical teacher", "weighted pupil", "classroom unit" or "weighted classroom unit". He reasoned that all variables such as types of roads, lengths of haul, costs of living, and contract prices were related positively or negatively with density of population. Density of population, being itself associated with the principal factors affecting costs,

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[20] R. L. Burns, The Measurement of the Need for Transporting Pupils, (Bureau of Publications, Teachers College, Columbia University, 1927), pp.53-59, cited by Asael C. Lambert, School Transportation, (Stanford, Stanford University Press, 1938), p. 57.

was looked upon as a summation of the effects of these various factors on costs of pupil transportation. Thus, density of population could be used as an independent variable for predicting such costs. A prediction equation which used percentage of average daily attendance per square mile was then applied, with certain adjustments, to all states. The application of this equation, particularly to unevenly populated areas, revealed some difficulties with the use of the density factor and many inaccuracies.[21]

Lambert's Study

Lambert was very critical of the work of Mort, Burns, Johns and others. He noted the many first-hand studies that had been made in small school areas and decried the fact that they had been ignored by the theorists. He stated:

> To the extent that programs of state school financing rely upon prediction techniques and ignore the relationships and factors shown by first-hand studies to be operative, they will substitute estimates for facts, opinions for evidence, and expedients for principles.[22]

Lambert went on to list in detail some of the many factors he viewed as affecting pupil transportation costs independently of the density of population factor. He mentioned such factors as:

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[21] See Asael C. Lambert, School Transportation, (Stanford, Stanford University Press, 1938), pp. 59-64, citing R. L. Johns, State and Local Administration of School Transportation, (Bureau of Publications, Teachers College, Columbia University, 1928).

[22] Ibid., p. 48.

> ... natural barriers and civil boundaries; patterns in which dwellings are scattered on the land; mean running speeds of vehicles; capacities of vehicles that can be used; amounts, quality, and configuration of highways; the time factor; numbers of pupils who live beyond an accepted walking distance; limits of reasonable walking distances; and the school organization factor.[23]

Perhaps a major value of Lambert's study was the doubts it cast upon the use of measures of density of population and the encouragement it offered to others to continue the search for more comprehensive measures of transportation need.

Noble's Analysis

More than seventy individual factors have been identified by Noble as having a definite influence upon pupil transportation costs. They were divided into two groups, as follows:

(1) Managerial factors: purchase price of bus, salary of driver, depreciation, storage, interest, etc.[24]

(2) Natural factors: roads, density of population, etc.[25]

In 1940, Noble published an analysis of formulae used in Alabama, Oklahoma, and Ohio. In each case he found that emphasis was placed upon the use of regression equations, in which the common factor in the calculation of pupil transportation costs was some measure of density of population.

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[23] Ibid., p. 118.

[24] Noble estimates these factors account from 2/3 to 3/4 of costs.

[25] Noble estimates these factors account from 1/4 to 1/3 of costs.

In Alabama, transportation costs were predicted by multiplying the aggregate attendance of the children transported by the average daily per pupil cost of transportation for counties with given densities of population.

In Oklahoma, the amount of transportation grant was determined by multiplying the average number of pupils legally transported daily by the district, during the month in the preceding year in which the greatest number of pupils had been transported, by an amount per pupil contained in a schedule of costs. The average number of pupils per square mile was determined by dividing twice the number of legally transported pupils living inside the district plus the number of legally transported pupils living outside the district, by twice the area of the district plus the area served by the district for transferred pupils.[26]

An evaluation of the Ohio plan states:

> The plan procedure employs the three most significant and valid factors beyond the control of the board of education (the number of pupils transported in the district, the number of pupils transported per square mile, and road conditions) in a regression equation for each district and then adjusting a right cost in terms of seven influential and valid managerial policies.[27]

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[26]See M. C. S. Noble, Pupil Transportation in the United States (Scranton, Pa.: International Textbook Co., 1940), p. 172.

[27]Ibid., p. 175. Managerial factors -- pupils per vehicle, investment per pupil, trips per bus, percentage of capacity used, bus miles per square mile, and number of schools to which pupils are transported.

Evans' Study

Evans' approach made use of the mathematical analysis technique as a means of establishing the mean costs of various types of pupil transportation, but did not include the density of population factor. He indicated that over half the costs of pupil transportation were not related to the density of population factor. He looked upon the cost per mile, the seat-mile, and the pupil-mile as indicative of apparent rather than real differences in costs of pupil transportation. He used daily round trip mileage and size of bus as the two most important determinants of actual costs. Using actual costs and employing correlations and multiple regression equations he established significant relationships.[28]

Burke's Analysis

Burke admitted that the sparsity measures would provide only a rough index of how much transportation was needed and maintained that a blanket sparsity measure applied to a large unit would not reveal true need. Density, he indicated, probably was reflected in increased costs of pupil transportation in this way: the farther the density fell below ten elementary pupils per square mile, or for high school pupils the farther the density fell below five pupils per square mile, the greater was the cost of providing transportation services.

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[28] See Arvid J. Burke, Financing Public Schools in the United States. (New York, Harper and Brothers, 1951), p. 622.

He went on to list many of the factors which he felt influenced the need for transportation and the cost of transportation and stated:

> It is not possible to fix costs in a state aid formula which would be appropriate for all operating conditions encountered in providing transportation. Neither is it possible to rule our managerial factors completely in establishing costs for purposes of state aid.[29]

Burke favored a state-operated and state-financed pupil transportation system and felt that it would in no way violate the principle of local autonomy in school government. He maintained that:

> ... even if there were no net economy by a state operated system, the freeing of local resources from the burden of transportation would strengthen other school operations.[30]

Johns' Recent Criteria

In some of his more recent writings Johns stated that a plan for state support for pupil transportation would not be adequate unless it:

1. provided adequate transportation service for all who need it;
2. encouraged efficiency and discouraged extravagance in local management;
3. was based on equitable considerations of all substantial variations in necessary transportation costs resulting from factors beyond local control;

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[29] Ibid., p. 617.

[30] Ibid., p. 619.

4. was based on completely objective analysis; and
5. was part of a balanced program of education financed by an equitable taxing system.[31]

He indicated that a formula must not be based on semi-empirical methods in establishing relationships between the costs of pupil transportation and the variables in the formula, but rather that it must be calculated entirely by mathematical methods.

Flathmann's Study

In line with the criteria stated by Johns, and after a careful analysis of factors affecting costs of pupil transportation, Flathmann inferred that the density of transported pupils per square mile of area served and the percentage of hard surfaced roads over which school buses travel were the two most important factors affecting pupil transportation costs. She then went on the develop a formula based on these two factors for predicting transportation costs for counties in Florida.

Flathmann showed by statistical analysis that the following mathematical function expressed the relationship between transportation costs and the predictive factors:

$$Y = \frac{A}{X} + \frac{B}{X^2} + \frac{C}{Z} + D, \text{ where}$$

Y = the annual cost in dollars per transported pupil for operating expenses and depreciation; X = the average daily attendance of transported pupils divided by the square miles of area served by

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[31] R. L. Johns, "Determining Pupil Transportation Costs," The Nation's Schools. XLIII, February, 1949, p. 49.

buses; Z = the number of miles of hard surfaced roads travelled by buses divided by the total miles travelled; and A, B, C, D are constants. The values of constants for the state of Florida were calculated by the method of "least squares".

The formula could be obtained only by carefully planned statistical procedures applied either to allocate state funds for transportation as part of a foundation program or to distribute a special fund for transportation.[32]

Mowat's Study

Mowat, in one of the few Canadian studies, accepted Evans' approach in principle, but rejected the road factor. Using Alberta figures for the previous year, correlations were arrived at for the three combinations of costs per day, total pupil load, and round trip mileage for each of four types of bus groups. The four bus groups were arranged as Group I: up to 8 pupils; Group II: 9 - 19 pupils; Group III: 20 - 40 pupils; and Group IV: above 40 pupils. By means of multiple regression equations a formula was arrived at for each group, from which standardized costs could be computed. The derived formula for Group I vehicles was:

$$C = 0.557\,N + 0.308\,P + 0.172\,M$$ where

N = group total days,

P = total pupil load, and

M = total round trip mileage.

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[32] See Ibid., p. 50.

Mowat found that differences between actual costs and standardized costs, whether the latter were higher or lower than the former, held the rate of tax effort in 47 out of 49 cases to within 0.08 per cent of the eleven mill rate which he used in his calculations. He concluded that the use of such formula was justified in dealing with transportation costs as part of the foundation program. The sharing of costs in that study was based on the assumption that total costs (made up of instructional costs and conveyance), less the sum derived by applying an approved mill rate to assessment, would equal the provincial share. It should be noted that under this arrangement the province, in certain instances, would pay the full costs of pupil transportation. This appeared to be a reasonable feature, particularly for those areas of high pupil transportation costs and low assessments.[33]

EXAMPLES OF FORMULAE USED FOR COMPUTING PUPIL TRANSPORTATION COSTS

The foregoing review of the literature illustrated the continuous efforts made from 1925 to 1960 to discover factors which would comprise an adequate and comprehensive basis for determining the need for pupil transportation services and calculating the "standardized" costs of providing these services. The efforts to use "density" and "sparsity" factors or measures for the calculation

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[33] See Mowat, op. cit.

of shareable pupil transportation costs in a foundation program, and some apparent success in doing so, are further revealed by the following descriptions of provisions in four regions of the United States.

Indiana Formula for State Support of Transportation.[34]

This formula provided for a basic support in the amount of $20.00 per pupil transported more than one and one-half miles. This amount was adjusted by the application of a sparsity and ability factor. Sparsity was defined as the ratio of the number of transported pupils to the round trip mileage of all bus routes. Ability was defined as the ratio of adjusted assessed valuation of the district to the number of resident pupils. The resulting formula was expressed mathematically as: State support per pupil = Sparsity factor X Ability factor X $20.00. The factors were so arranged that the amount of state support varied directly as pupil sparsity in a school district and inversely as the taxable wealth per pupil.

State Aid For Transportation in Arkansas.[35]

The two basic factors in this formula were density of transported children and depreciation on approved vehicles. An allowance per pupil was based on the density factor which was determined by

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[34]Montfort W. Barr, "The Indiana Formula for State Support of Transportation," School Executive. 75, November, 1955, pp. 56-57.

[35]J. L. Eidson, "State Aid for Transportation in Arkansas," The Nation's Schools, Vol. 49, No. 5, May, 1952, pp. 84-86.

dividing the average number of pupils transported daily by the total area of the district in square miles. A scatter diagram based on density and actual cost per pupil was plotted for each district to establish the average cost per child for a given density. The allowance per pupil varied from $16.00 to $38.00 with the lower-density districts receiving the higher rate. The allowance for depreciation, based on a ten-year period of service, provided an annual amount of money that would in ten years approximately equal the cost of replacing the vehicle.

Transportation in South Dakota[36]

The formula provided for an allotment per pupil based on a sparsity factor computed from the number of pupils transported and dwelling-to-school distances for each of the pupils. After plotting costs against the sparsity factor and observing the nature of the dispersion, a regression line was obtained which was used as a measure of transportation need.

An alternate formula obtained by using a second independent variable, total miles of bus route, was also developed in a similar manner.

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[36] Kenneth E. McIntyre, and Richard J. Combs, "Transportation: A Basis for Distributing State Funds." The Nation's Schools, Vol. 49, No. 3, March 1952, pp. 51-53.

Transportation Formula For Kentucky[37]

The formula was based upon the number of transported pupils in average daily attendance, area in square miles served by buses, and the daily cost per pupil. The number of transported pupils in average daily attendance was divided by the number of square miles of area served. The quotient was taken as a measure of pupil density. The daily cost per pupil was found by dividing the total annual costs of transportation, including depreciation, by the product of the average daily attendance of transported pupils and the number of days school was in session. These figures were determined for each district and arranged in nine comparable groups. An average density for each group was found. After plotting the average density against the daily cost per pupil, a smooth curve was constructed that best fitted the density groups. From this graph a scale showing the average costs of transportation for districts of similar densities was constructed. This scale was used to find the adjusted daily cost per pupil. To determine the total allotment for pupil transportation to any district the average daily attendance of transported pupils was multiplied by the number of days they were transported and by the adjusted daily cost per pupil.

MEASURES RELATED TO COSTS OF PUPIL TRANSPORTATION

The preceding formulae, given in summary, have illustrated

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[37]Department of Education, Frankfort, Kentucky, "A Proposed Transportation Formula, Vol. XXVI, April 1958.

some applications of measures of density of population (or sparsity) as partial determinants of pupil transportation costs.

These formulae and the studies reported earlier were examined further to discover whether they contained any common acknowledgment of types of factors which affected the costs of pupil transportation. The following types were noted as having received some recognition:

(1) Numbers of pupils: for example, the number of pupils transported, the number of pupils that must be transported by law, the number of pupils in average daily attendance;

(2) Area Served: for example, the distances over which pupils were transported, the area in acres or in square miles, the daily round trip mileage of all buses;

(3) Policy: for example, the pattern of school organization followed, the size of vehicles used, the contract prices paid; and

(4) Topography: for example, the conditions of roads, the geographic features of the area, the physio-economic features, and the natural barriers.

Still further examination revealed that the measures could be classified into three groups:

(1) Those measures of "density" or "sparsity" of population which were based upon distances or mileages as one of the factors in the measure. Examples of these measures were bus miles per transported pupil or the number of pupils combined with the dwelling-to-school distances.

(2) Those measures which were based upon area in square miles or in acres as one of the factors in the measure. Examples of these measures were acres per transported pupil or the number of pupils per square mile.

(3) Other measures of a miscellaneous nature involving neither distances nor area, but which were considered as having probable relationships to the costs of pupil transportation. Examples of these measures were equalized assessment per pupil or percentage of total enrolment transported.

SELECTION OF MEASURES FOR THIS STUDY

From the analysis of the factors and the measures revealed in the literature, fourteen measures were abstracted for use in this study. A few of the measures were explicitly treated in the literature; the majority were suggested by it. These measures, which will be defined and illustrated on pages 56 to 72 are listed below in three groups corresponding to the above classification:

Group I Measures

1. Weighted average pupil-district distance;
2. Bus miles per transported pupil;
3. Bus miles per statutory transported pupil;
4. Bus miles per square mile of organized districts;
5. Pupil-average distance.

Group II Measures

6. Acres of organized districts per statutory transported pupil;

7. Assessed acreage per unit of population;

8. Total acreage per unit of population;

9. Assessed acreage per statutory transported pupil;

10. Population per square mile of organized districts;

11. Statutory transported pupils per square mile of organized districts;

Group III Measures

12. Equalized assessment per statutory transported pupil;

13. Statutory transported pupils per bus operated; and

14. Per cent of pupils transported.

The general characteristics of the measures are worthy of note. Some of the measures are almost purely demographic, i.e. dependent upon numbers of pupils and the locations of their homes; others are largely operational, i.e. dependent on practices and policies of local school authorities and subject readily to local modification. For example, school population per square mile is fixed for any school division or county regardless of board policies. On the other hand, the number of transported pupils per bus mile is, in some degree, subject to local board policies. A board could increase or decrease the number of transported pupils as well as the daily number of miles travelled by buses. These factors could be varied by providing gate service for all statutory transported pupils or by providing transportation services for pupils living less than one and one-half miles from the school. Many of the measures are "mixtures" of

demographic and operational factors, i.e. based on constant or natural conditions but also subject in varying degrees to policies and practices of school authorities.

Group I measures are heavily subject to operational policies although the sparsity and distribution of school population, too, are an influence. Group II measures which utilize "number of pupils transported" include some operational influence but others are purely demographic. In Group III, the measure of "equalized assessment per statutory transported pupil" embodies an assumption that differences in costs of pupil transportation are related to the ability to pay; the measure of "statutory transported pupils per bus operated" assumes that the size of load reflects considerations taken by school authorities regarding population scatter, distances of children from central schools, and the utilization of pupil transportation equipment; the measure of "per cent of pupils transported" relates to the degree of centralization and urbanization or the absence of them.

The relationship between each of the measures and the costs of pupil transportation will be shown in Chapter III.

SUMMARY

This chapter has traced the trends in the use of density measures for calculating the costs of pupil transportation and has illustrated four methods used for including such costs in foundation programs. It has revealed some of the factors which could be used in

calculating measures of density or population scatter.

Regarding the determination of pupil transportation costs, the literature indicated that consideration must be given to (1) the number of pupils requiring transportation, (2) the area over which the pupils are scattered, (3) the policies of school authorities relating to pupil transportation, and (4) the topography of the area served by a pupil transportation system.

The author agrees, therefore, that factors which are used to determine standardized costs of pupil transportation must reflect both demographic and operational circumstances. The literature suggests that problems exist in relation to establishing valid quantitative expressions of factors of the type mentioned above, particularly those dealing with policies and topography.

The literature included in this chapter illustrates the preference of researchers that demographic factors be used. The views of Burns on this matter were typical. He held that it would be best to determine the necessary transportation costs in terms of a natural or constant (demographic) condition that would not be subject to the whims or policies of local school authorities. A measure of such a condition was referred to as "a variable which is not susceptible to local control or policies as far as the minimum program is concerned.[38]

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[38]Burns, op. cit., p. 54.

A vital question persisted, however, in the minds of many researchers: Could such natural or constant (demographic) factors alone adequately account for the variations that exist in pupil transportation costs in different areas of the country?

The above question was the central interest of this study. On the basis of the types of factors suggested by the literature, fourteen measures were developed for testing relationships between them and the costs of pupil transportation. These measures, arranged in three groups, were considered as having possible usefulness for determining standardized pupil transportation costs in Alberta. The derivation of these measures, their calculation, and their statistical treatment will be discussed in the next chapter.

CHAPTER III

THE DATA, PROCEDURES, AND FINDINGS

This chapter will present the nature of the required data, the sources from which the data were obtained, the organization of the data into suitable form for the calculation of the measures, and the description and derivation of the density measures.

The values of the fourteen measures selected in Chapter II will be calculated and correlations will be derived between each measure and the costs of pupil transportation. Inter-correlations among the measures will also be determined and a procedure will be used to establish the order in which combinations of measures may be used to provide the best predictions of costs of pupil transportation. Finally, the findings will be summarized.

THE DATA

The data on which this study was based consisted of (1) official statements of provincial payments in 1961 from the Foundation Program Fund to divisions and counties relative to pupil transportation, (2) official returns of local school authorities to the Department of Education, (3) statements of taxable and equalized assessments, and (4) population and acreage figures for each administrative unit.

The Types of Data

Each of the fourteen measures chosen for this study in Chapter II

was a complex measure, i.e., its numerical value had to be calculated from two or more other quantities. Each measure was carefully scrutinized, therefore, and the types of basic data required for its derivation were determined. The data required for the calculations were obtained for each of the 39 school divisions and 20 counties in Alberta for the year 1961. They were:

1. Pupil-district distance, June and December terms;
2. Statutory transported pupils, June and December terms;
3. Total acreage of organized districts;
4. Daily bus mileage;
5. Total pupils transported daily;
6. Number of centralized schools;
7. Number of buses operated;
8. Total school enrolment;
9. Equalized assessment;
10. Total resident population;
11. Total assessed acreage; and
12. Total acreage within boundaries.

Two further types of data were required to complete the study. There were:

13. Costs of pupil transportation; and
14. Grants for pupil transportation.

The former was required for finding correlations of each of the measures with the costs of pupil transportation; the latter was

required in Chapter IV to compare the costs of and the grants for pupil transportation in each division and county with the predicted costs obtained by using the derived regression equations.

The Sources of the Data

The sources of the required data were official returns of school authorities to the Department of Education, Annual Reports of the Department of Education, and reports of the Department of Municipal Affairs.

Data on (1) the costs of pupil transportation, (2) the grants for pupil transportation, (3) the pupil-district distance for each term, (4) the number of statutory transported pupils in each term, and (5) the total acreage of organized districts were secured from the official returns of local school authorities to the Department of Education. These data are listed in Appendix B, Table XII, page 139.

The Annual Reports of the Department of Education provided information on (1) the daily bus mileage, (2) the total number of pupils transported daily, (3) the number of centralized schools, (4) the number of buses operated, and (5) the total school enrolment in each division and county. These data are listed in Appendix B, Table XIII, page 141.

The Department of Municipal Affairs reports provided information on (1) the equalized assessments, (2) the total resident population, (3) the total assessed acreage, and (4) the total

acreage included within the boundaries of each division and county. These data are listed in Appendix B, Table XIV, page 143 . The breakdown of equalized assessments for each division and county are listed in Appendix A, Table XI, page 122.

The Treatment of the Data

The data used in developing, deriving, and illustrating the measures were required for the year 1961. However, in some cases, the data were reported for each school term ending on June 30 and December 31. In order that the transportation need could be measured for a period of time coincident with that of the financial year ending December 31, it was necessary to adjust the data to apply to the calendar year. This adjustment was done by "weighting" the data. The data for the June term were multiplied by six (corresponding to the six months in the term) and the data for the December term were multiplied by four (corresponding to the four months in the term). These products were then added and the sum divided by ten to obtain a weighted average for the calendar year. The above correction applied to the daily bus mileage, the number of pupils transported daily, the statutory transported pupils, and the pupil-district distance.

The data on equalized assessments and on population, based on municipal administrative units, required some adjustments in a few cases. These adjustments were necessary where boundaries for school divisions or counties did not coincide with municipal areas. Approximate proportions were utilized for this purpose.

DESCRIPTION, DERIVATION AND INTERPRETATION OF MEASURES

The basic data compiled in Tables XII, XIII, and XIV were then used to calculate the values of the fourteen measures selected in Chapter II for each division and county. The measures are treated below in three groups. The following sections, therefore, describe each measure, indicate how the value of each was derived, and interpret by way of examples the meaning of the computed value in relation to conditions existing in Alberta school divisions and counties.

Group I Measures

The measures in this group include those which utilize distances or mileages as one of the factors in the computation of the measure.

Weighted Average Pupil-District Distance. This measure was obtained by finding the product of the number of pupils in a district and the district distance. District distance was defined as the distance measured directly along north and south lines or east and west lines from the most distant point of the district to the school attended by the pupils of the district, decreased by 1.5 miles. District distance was established for each district in a division or county. The pupil-district distances applicable to all districts in a division or county were then added.

A separate set of figures were available for the June term

as shown in Table XII, page 139, Column (4) and the December term, Table XII, page 139, Column (5). To obtain the weighted average of the pupil-district distance for the year, therefore, these figures were weighted as described above. The numerical values of this measure for each division and county are listed in Table II, Column (2).

The values of this measure were noted to vary from a low of 951.6 for the Northland School Division to a high of 24,402.9 for the Red Deer School Division. Variations indicated differences in the number of pupils transported and in the distances the pupils were transported to central schools in the divisions and counties. The value of this measure for a division or county might change from one term to another if the number of pupils in a district increased or decreased or if pupils from any district were directed to attend another central school.

Bus Miles Per Transported Pupil. This measure was obtained by dividing the maximum total daily mileage travelled by all buses in each division and county, Table XIII, page 141, Column (2) by the maximum total daily load carried by the buses, Table XIII, page 141, Column (3). This quotient was a measure of density of population which for each division and county was listed in Table II, Column (3).

The numerical values of this measure varied from a low of 0.87 in the Peace River School Division to a high of 4.45 in the Acadia School Division. The values indicated that for every pupil transported in Peace River a bus travelled, on the average, 0.87 miles

TABLE II

CALCULATED VALUES OF GROUP I MEASURES OF DENSITY

Division or County Name and Number		Weighted Average Pupil-District Distance	Bus Miles Per Transported Pupil	Bus Miles Per Statutory Transported Pupil	Bus Miles Per Square Mile of Organized Districts	Pupil-Average Distance
(1)		(2)	(3)	(4)	(5)	(6)
Berry Creek	1	3,046.8	3.94	2.99	0.28	4,986.2
Cardston	2	10,216.4	2.31	2.14	1.66	14,269.2
Medicine Hat	4	12,963.7	1.50	1.60	0.65	21,352.2
Taber	6	15,153.9	1.56	1.66	1.69	23,166.0
Lethbridge	7	13,917.6	1.43	1.62	2.93	16,205.6
Acadia	8	6,823.3	4.45	4.32	1.12	11,230.7
Sullivan Lake	9	4,029.8	2.76	2.93	0.87	8,535.0
Peace River	10	16,588.8	0.87	0.93	0.88	20,024.4
Lac Ste Anne	11	16,218.7	1.67	1.92	2.52	20,183.8
Edson	12	15,992.6	1.51	1.74	1.98	20,407.3
Rocky Mountain	15	13,151.7	1.76	1.67	2.14	15,110.7
Neutral Hills	16	5,177.5	3.69	3.81	1.14	9,501.8
Lamont	18	18,377.2	1.69	1.74	3.08	19,744.4
Vegreville	19	18,783.7	1.94	1.97	2.46	22,786.6
Camrose	20	22,462.0	1.67	1.74	3.13	24,502.7
Two Hills	21	14,174.4	1.99	1.92	2.92	23,079.7
Killam	22	15,075.0	1.90	2.10	2.17	18,463.2
Stony Plain	23	22,339.0	1.26	1.41	2.60	22,418.1
Vermilion	25	17,718.9	2.00	2.07	2.05	26,516.0
MacLeod	28	12,576.0	3.87	3.51	2.19	19,238.7
Pincher Creek	29	9,710.9	2.64	2.60	1.92	15,715.7
Drumheller	30	7,244.3	2.81	3.09	2.21	8,710.1
Wainwright	32	10,605.1	2.46	2.77	1.79	16,290.5
Provost	33	7,889.5	3.07	3.22	1.64	10,269.4
Red Deer	35	29,402.9	1.57	1.47	2.61	32,220.2
Westlock	37	18,436.2	1.40	1.61	2.28	18,102.3
Foothills	38	12,632.7	2.29	2.36	2.53	15,882.6
Calgary	41	21,851.4	2.24	2.08	2.56	24,798.3

TABLE II (Continued)

Division or County Name and Number		Weighted Average Pupil-District Distance	Bus Miles Per Transported Pupil	Bus Miles Per Statutory Transported Pupil	Bus Miles Per Square Mile of Organized Districts	Pupil-Average Distance
(1)		(2)	(3)	(4)	(5)	(6)
Bonnyville	46	20,452.7	2.12	1.85	3.06	23,188.4
Spirit River	47	15,616.6	1.77	1.78	1.83	20,431.9
High Prairie	48	17,587.7	1.14	1.16	1.31	17,273.2
Leduc	49	20,417.5	1.17	1.27	2.16	25,238.2
Fairview	50	11,788.6	1.93	1.97	1.71	15,290.9
Lac La Biche	51	7,220.0	1.03	1.30	1.04	9,743.5
Fort Vermilion	52	2,223.5	1.04	0.85	0.26	4,585.0
East Smoky	54	4,975.7	1.39	1.65	1.90	5,978.9
Red Deer Valley	55	2,231.4	1.66	0.79	3.20	1,001.9
Three Hills	60	13,383.3	2.21	2.48	2.76	16,886.1
Northland	61	951.6	1.26	1.29	0.09	2,217.1
Counties						
Grande Prairie	1	18,680.0	1.22	1.30	1.43	24,623.9
Vulcan	2	15,922.3	3.19	3.04	2.02	20,438.9
Ponoka	3	17,906.0	1.13	1.23	2.17	24,589.3
Newell	4	14,152.4	1.77	1.71	1.80	15,454.0
Warner	5	10,179.3	2.57	2.52	1.63	15,502.2
Stettler	6	11,987.7	2.56	2.75	2.21	15,872.2
Thorhild	7	11,268.4	1.37	1.30	1.86	17,011.5
Forty Mile	8	12,258.4	3.19	3.43	1.26	20,509.7
Beaver	9	16,945.1	2.06	1.97	2.56	23,716.3
Wetaskiwin	10	20,581.3	1.37	1.23	2.29	22,249.2
Barrhead	11	14,952.6	1.35	1.41	2.04	17,895.9
Athabasca	12	19,692.8	2.15	2.40	2.63	23,119.7
Smoky Lake	13	10,681,7	1.70	1.82	2.67	13,098.7
Lacombe	14	16,633.2	1.42	1.67	2.81	21,136.8
Sturgeon	15	15,508.5	1.12	1.12	3.38	17,779.1
Wheatland	16	13,402.8	2.75	2.72	2.08	18,355.0
Mountain View	17	22,083.3	2.05	2.07	2.91	26,632.0
Paintearth	18	9,791.1	2.92	3.31	2.25	15,697.5
St. Paul	19	16,011.1	1.72	1.84	2.75	19,477.3
Strathcona	20	16,584.7	0.91	1.02	3.61	18,443.9

while in Acadia it travelled 4.45 miles per transported pupil. The value of this measure for a division or county might change from one term to another for two reasons. The one factor, bus miles, could be changed by board policies calling for gate service thereby increasing the number of bus miles; the other factor, number of transported pupils, could be increased by removing restrictions on maximum walking distances for pupils to a school.

Bus Miles Per Statutory Transported Pupil. The procedure used to obtain this measure was similar to the one used in obtaining the measure of bus miles per transported pupil. In the calculation of this measure, however, only those pupils who lived beyond the distance specified in provincial statutes were included. The term, statutory transported pupil, referred to those pupils who lived beyond one and one-half miles from the school they were directed to attend and who had to be provided, by provincial statutes, with transportation or a boarding allowance. The measure was obtained by dividing the total maximum daily mileage travelled by all buses in each division and county, Table XIII, page 141, Column (2) by the weighted average of statutory transported pupils calculated from Table XII, page 139,Columns (6) and (7). The resulting values of this measure for each division and county were listed in Table II, Column (4).

This measure ranged in value from a low of 0.79 in the Red Deer Valley School Division to a high of 4.32 in the Acadia School Division. The values indicated that for every statutory transported pupil in Red

Deer Valley the bus travelled 0.79 miles while in Acadia it travelled 4.32 miles. Variations in this measure might result from changes in the number of bus miles, but the measure was reasonably independent of local manipulation because it included only those pupils who lived beyond one and one-half miles from the school they were directed to attend.

Bus Miles Per Square Mile of Organized Districts. To obtain this measure of pupil density it was first necessary to divide the total acreage of organized districts, Table XII, page 139,Column (8) by 640 to obtain in square miles the area of organized districts in each division and county. Then, the daily bus mileage, Table XIII, page 141, Column (2) was divided by the number of square miles of organized districts. The resulting values for each division and county were listed in Table II, Column (5).

The measure of density ranged in value from a low of 0.09 in Northland School Division to 3.61 in Strathcona County. It indicated that in Northland the area was large and transportation services were limited while in Strathcona the entire area was organized into districts and an extensive transportation system developed. The wide variation in this measure indicated that in some divisions and counties only a small proportion of the area was served by buses while in others bus routes interlaced almost every square mile of area. The measure would be only slightly subject to local manipulation. The daily bus mileage might be varied by local board policies but the number of square miles of organized districts would be fairly constant from

year to year.

Pupil-Average Distance. To obtain this measure of scatter of pupil population several steps were necessary. The figures for the total number of acres of organized districts, Table XII, page 139, Column (8) were first divided by 640 to obtain the number of square miles of organized districts in each division and county. When the number of square miles of organized districts was divided by the number of centralized schools, Table XIII, page 141, Column (4) the average number of square miles of organized districts per centralized school was determined. Extracting the square root of this value gave the approximate distance over which pupils, on the average, would have to be transported to school. When this average distance was multiplied by the weighted average of the number of statutory transported pupils, calculated from Table XIII, page 141,Columns (6) and (7), the pupil-average distance for each division and county was obtained. Values of this measure were listed in Table II, Column (6).

This measure ranged in value from a low of 1,001.9 in the Red Deer Valley School Division to a high of 32,220.2 in the Red Deer School Division. It indicated the variation in the number of pupils transported and in the distances they were transported to centralized schools. Variations, both in number of pupils transported and in the average distances, would be relatively independent of local board policies.

Group II Measures

The measures in this group include those which utilize area

in square miles or in acres as one of the factors in the computation of measure.

Acres of Organized Districts Per Statutory Transported Pupil. This measure of density was obtained by dividing the total acreage of organized districts in each division and county, Table XII, page 139, Column (8) by the weighted average of the number of statutory transported pupils, calculated from Table XII, page 139, Columns (6) and (7). Values of this measure of density have been listed in Table III, Column (2) for each division and county.

The values of this measure ranged from a low of 150 acres of organized districts per statutory transported pupil in the Red Deer Valley School Division to a high of 7,001 acres in the Berry Creek School Division. The range of values indicated that in some divisions and counties there were, on the average, approximately four pupils on every section of land, while in others there were approximately four pupils on every eleven sections of land. The measure would remain fairly constant because the factors from which it was obtained could not be varied appreciably by changes in policies of school authorities.

Assessed Acreage Per Unit of Population. This measure was obtained by dividing the total assessed acreage in each division and county, Table XIV, page 143, Column (4) by the total resident population, Table XIV, page 143, Column (3). Values of this measure have been listed in Table III, Column (3).

The values of this measure ranged from a low of 6.8 acres

TABLE III

CALCULATED VALUES OF GROUP II MEASURES OF DENSITY

Division or County Name and Number		Acres of Organized Districts Per Statutory Transported Pupil	Assessed Acreage Per Unit of Population	Total Acreage Per Unit of Population	Assessed Acreage Per Statutory Transported Pupil	Population Per Square Mile of Organized Districts	Statutory Transported Pupils Per Square Mile of Organized Districts
(1)		(2)	(3)	(4)	(5)	(6)	(7)
Berry Creek	1	7,001	175.1	567.7	1,524.8	0.83	0.095
Cardston	2	839	137.7	153.7	718.9	4.05	0.776
Medicine Hat	4	1,440	219.9	566.4	1,108.3	2.04	0.404
Taber	6	612	106.0	158.9	469.3	4.51	1.018
Lethbridge	7	351	58.3	60.7	360.6	11.17	1.807
Acadia	8	2,374	188.0	469.9	993.3	1.37	0.259
Sullivan Lake	9	2,266	175.1	576.6	852.8	1.44	0.283
Peace River	10	659	85.5	554.5	416.8	4.64	0.952
Lac Ste Anne	11	477	88.5	192.3	373.7	5.52	1.308
Edson	12	544	58.1	883.6	278.6	5.53	1.138
Rocky Mountain	15	485	87.1	453.4	406.5	5.97	1.278
Neutral Hills	16	2,180	175.1	576.6	807.5	1.39	0.301
Lamont	18	362	75.6	801.2	344.9	8.05	1.766
Vegreville	19	511	116.9	125.2	475.9	5.09	1.251
Camrose	20	339	85.2	87.4	349.5	7.37	1.797
Two Hills	21	453	87.5	94.4	390.1	6.80	1.524
Killam	22	622	148.0	150.8	674.3	4.72	1.035
Stony Plain	23	309	55.6	78.2	297.6	9.84	1.838
Vermilion	25	627	122.1	133.5	597.0	4.84	0.990
MacLeod	28	1,008	158.3	186.2	957.3	3.77	0.624
Pincher Creek	29	881	176.2	229.8	766.0	3.22	0.740
Drumheller	30	857	196.3	226.0	807.6	2.94	0.715
Wainwright	32	943	148.9	179.3	858.3	3.73	0.646
Provost	33	1,275	200.9	249.9	1,060.6	2.69	0.510
Red Deer	35	340	75.0	79.0	364.4	8.62	1.774
Westlock	37	448	70.5	131.0	379.7	7.64	1.418
Foothills	38	591	104.4	104.4	667.4	6.84	1.070
Calgary	41	614	70.1	104.4	543.8	9.57	1.234
Bonnyville	46	429	45.7	151.7	290.5	10.50	1.652
Spirit River	47	585	106.5	350.1	491.6	4.75	1.030
High Prairie	48	529	58.9	296.5	381.3	7.29	1.212

TABLE III (Continued)

Division or County Name and Number (1)		Acres of Organized Districts Per Statutory Transported Pupil (2)	Assessed Acreage Per Unit of Population (3)	Total Acreage Per Unit of Population (4)	Assessed Acreage Per Statutory Transported Pupil (5)	Population Per Square Mile of Organized Districts (6)	Statutory Transported Pupils Per Square Mile of Organized Districts (7)
Leduc	49	364	67.6	81.5	318.3	8.01	1.700
Fairview	50	751	98.8	1,517.1	833.3	7.30	0.866
Lac La Biche	51	764	52.8	361.8	315.7	4.80	0.803
Fort Vermilion	52	1,693	36.6	4,693.2	367.8	3.12	0.310
East Smoky	54	521	61.6	2,040.5	324.3	6.03	1.145
Red Deer Valley	55	150	6.8	7.8	147.4	87.61	4.029
Three Hills	60	561	115.7	118.3	575.3	5.53	1.113
Northland	61	3,832	29.1	11,140.6	785.2	1.85	0.068
Counties							
Grande Prairie	1	561	105.1	159.5	496.4	5.21	1.103
Vulcan	2	1,033	206.7	255.7	829.7	2.67	0.666
Ponoka	3	343	73.3	93.5	340.7	8.15	1.755
Newell	4	581	243.6	250.3	1,102.4	4.77	1.053
Warner	5	1,003	196.6	196.6	889.5	2.92	0.646
Stettler	6	731	157.1	164.1	780.6	3.98	0.801
Thorhild	7	465	74.7	92.8	353.5	6.76	1.430
Forty Mile	8	1,795	273.7	424.3	1,126.8	1.51	0.367
Beaver	9	496	112.5	130.9	472.6	5.48	1.304
Wetaskiwin	10	333	64.4	92.2	290.5	8.43	1.870
Barrhead	11	435	75.9	220.8	343.1	6.52	1.461
Athabasca	12	586	75.6	170.7	360.7	5.23	1.096
Smoky Lake	13	416	72.4	127.2	348.1	7.06	1.468
Lacombe	14	347	81.3	89.8	373.3	7.73	1.685
Sturgeon	15	211	35.9	38.1	212.1	17.91	3.028
Wheatland	16	881	196.3	219.0	861.3	3.35	0.763
Mountain View	17	412	94.1	100.3	419.6	6.28	1.408
Paintearth	18	876	251.6	265.1	891.0	2.41	0.680
St. Paul	19	442	78.7	108.1	352.5	6.68	1.492
Strathcona	20	169	32.2	34.4	173.5	19.17	3.557

per resident in Red Deer Valley School Division to 273.7 acres per resident in the County of Forty Mile. It indicated that in Red Deer Valley there were over ninety residents per square mile of assessed acreage while in the County of Forty Mile there were just over two residents per square mile of assessed acreage. Variations in this measure were not subject to local manipulation.

Total Acreage Per Unit of Population. This measure was obtained by dividing the total acreage within the boundaries of each school division and county, Table XIV, page 143, Column (5) by the total resident population, Table XIV, page 143, Column (3). The values of this measure were listed in Table III, Column (4).

Values of this measure ranged from a low of 7.8 acres per resident in Red Deer Valley School Division to 4,693.2 acres per resident in the Fort Vermilion School Division. The range of values indicated that in Red Deer Valley there were, on the average, 600 times as many residents on any unit area as there were in Fort Vermilion. This measure was independent of policies of school authorities and not subject to local manipulation.

Assessed Acreage Per Statutory Transported Pupil. This measure was obtained by dividing the total assessed acreage in each division and county, Table XIV, page 143, Column (4) by the weighted average of the number of statutory transported pupils calculated from Table XII, page 139, Columns (6) and (7). The values of this measure were listed in Table III, Column (5).

The values of this measure varied from a low of 147.4 acres per statutory transported pupil in the Red Deer Valley School Division to a high of 1,524.8 acres per pupil in the Berry Creek School Division. The range of values of this measure indicated that in some divisions approximately one quarter section of taxable land existed per statutory transported pupil while in others there were as many as ten quarter sections of taxable land per statutory transported pupil. Variations in this measure would result largely if there were increases or decreases in the number of statutory transported pupils and would be only slightly affected by school board policies.

Population Per Square Mile of Organized Districts. To obtain this measure of density it was first necessary to divide the total acreage of organized districts, Table XII, page 139,Column (8) by 640 to obtain the area in square miles of organized districts in each division and county. Then, the total resident population, Table XIV, page 143, Column (3) was divided by the number of square miles of organized districts. The resulting values of this measure were listed in Table III, Column (6).

The values of the measure were observed to range from a low of 0.83 residents per square mile of organized districts in Berry Creek School Division to a high of 87.61 residents per square mile of organized districts in the Red Deer Valley School Division. The range of values indicated that in Red Deer Valley there were, on the average, more than 900 times as many residents on any unit area of organized districts as there were in Berry Creek. This measure would remain

constant regardless of school board policies.

Statutory Transported Pupils Per Square Mile of Organized Districts. This measure of pupil density was found by dividing the weighted average of the number of statutory transported pupils, calculated from Table XII, page 139, Columns (6) and (7), in each division and county by the number of square miles or organized districts. The number of square miles of organized districts was found by dividing the total acreage of organized districts, Table XII, page 139, Column (8) by 640. The values of this measure were listed in Table III, Column (7).

Values of this measure varied from a low of 0.068 statutory transported pupils per square mile of organized districts in the Northland School Division to a high of 4.029 pupils in the Red Deer Valley School Division. The range of values indicated that in some divisions there were nearly 60 times as many pupils on any unit area of organized districts who required transportation as there were in others. This measure could not be varied appreciably by policies of school authorities.

Group III Measures

The measures in this group are of a miscellaneous nature and include those which utilize neither distance nor area as factors in their computation.

Equalized Assessment Per Statutory Transported Pupil. This measure was obtained by dividing the equalized assessment for each

division and county, Table XIV, page 143, Column (2) by the weighted average of the number of statutory transported pupils obtained from Table XII, page 139, Columns (6) and (7). The values of this measure for each division and county were listed in Table IV, Column (2).

The values of this measure varied from a low of $1,171 per statutory transported pupil in the Fort Vermilion School Division to a high of $17,767 per pupil in the County of Strathcona. The range of values indicated that some divisions or counties had an equalized assessment per statutory transported pupil that was more than fifteen times as high as others. Slight variations in the values of the measure would result from changes in school organization, but otherwise values were largely independent of local school board policies.

Statutory Transported Pupils Per Bus Operated. This measure was obtained by dividing the weighted average of the number of statutory transported pupils in each division and county obtained from Table XII, page 139,Columns (6) and (7) by the number of buses operated, Table XIII, page 141,Column (5). The values of this measure for each division and county were listed in Table IV, Column (3).

Values of this measure varied from a low of 14.2 statutory transported pupils per bus in the Acadia School Division to a high of 53.6 pupils per bus in the County of Strathcona. Assuming that most buses were operated as near to capacity as was feasible and that transported pupils in each area spent about the same time travelling each day, the values indicated the relative size of buses operated in the divisions and counties. They illustrated that in Acadia relatively

TABLE IV

CALCULATED VALUES OF GROUP III MEASURES

Division or County Name and Number (1)		Assessment Per Statutory Transported Pupil (2)	Statutory Transported Pupils Per Bus Operated (3)	Per Cent Of Pupils Transported (4)
Berry Creek	1	$ 2,057	21.3	93.7
Cardston	2	11,549	25.2	36.6
Medicine Hat	4	6,250	20.3	83.8
Taber	6	8,294	39.1	56.4
Lethbridge	7	6,695	26.5	59.2
Acadia	8	12,136	14.2	57.4
Sullivan Lake	9	9,223	16.9	71.5
Peace River	10	5,562	31.4	58.0
Lac Ste Anne	11	4,265	32.3	64.3
Edson	12	10,490	42.1	42.9
Rocky Mountain	15	3,635	41.6	58.8
Neutral Hills	16	9,790	17.0	60.4
Lamont	18	7,277	42.2	72.2
Vegreville	19	7,719	34.5	69.5
Camrose	20	6,369	38.5	87.7
Two Hills	21	5,770	33.9	77.5
Killam	22	8,484	32.7	66.6
Stony Plain	23	9,984	38.7	56.1
Vermilion	25	9,178	27.3	72.1
MacLeod	28	16,087	19.1	42.1
Pincher Creek	29	12,813	27.5	57.3
Drumheller	30	10,029	20.8	72.4
Wainwright	32	11,877	27.6	47.2
Provost	33	10,612	22.1	67.1
Red Deer	35	7,198	45.5	54.0
Westlock	37	5,307	30.1	66.1
Foothills	38	10,724	28.7	79.3
Calgary	41	9,865	33.3	82.5
Bonnyville	46	2,184	42.5	82.6
Spirit River	47	4,306	38.7	79.5

TABLE IV (Continued)

Division or County Name and Number (1)		Assessment Per Statutory Transported Pupil (2)	Statutory Transported Pupils Per Bus Operated (3)	Per Cent of Pupils Transported (4)
High Prairie	48	$ 4,437	37.0	55.0
Leduc	49	9,622	44.8	59.9
Fairview	50	5,390	27.1	69.6
Lac La Biche	51	2,310	31.4	55.4
Fort Vermilion	52	1,171	40.5	40.5
East Smoky	54	3,494	38.2	61.8
Red Deer Valley	55	3,806	42.2	50.1
Three Hills	60	10,533	23.3	68.4
Northland	61	4,539	26.6	13.8
Counties				
Grande Prairie	1	5,117	40.1	74.2
Vulcan	2	13,696	22.1	65.9
Ponoka	3	7,497	37.1	54.9
Newell	4	5,949	27.4	75.2
Warner	5	12,255	23.9	42.1
Stettler	6	8,788	21.8	80.4
Thorhild	7	6,806	51.4	70.1
Forty Mile	8	12,232	20.5	67.5
Beaver	9	7,121	32.8	67.8
Wetaskiwin	10	5,164	47.7	91.0
Barrhead	11	4,094	40.0	64.1
Athabasca	12	3,333	28.2	69.3
Smoky Lake	13	4,404	38.3	69.4
Lacombe	14	10,852	33.7	50.6
Sturgeon	15	4,967	42.1	87.6
Wheatland	16	11,725	26.5	65.7
Mountain View	17	8,525	34.1	58.2
Paintearth	18	8,685	21.9	71.4
St. Paul	19	3,185	33.6	93.4
Strathcona	20	17,767	53.6	50.2

small buses were operated whereas in Strathcona large buses were in use. The measure also gave an indication of relative densities of pupil population in each division and county. Variations in this measure could be made by school board policies pertaining to length of time spent by pupils on a bus, but were largely governed by the scatter of population.

Per Cent of Pupils Transported. This measure was obtained by dividing the weighted average of the number of statutory transported pupils calculated from Table XII, page 139, Columns (6) and (7) by the total school enrolment in each division and county, Table XIII, page 141, Column (6) and converting the result to a per cent. Values of this measure were listed in Table IV, Column (4).

The values of this measure ranged from a low of 13.8 per cent in the Northland School Division to a high of 93.7 per cent in the Berry Creek School Division. The low percentage indicated generally the absence of the full impact of centralization or in other cases a large proportion of pupils living near enough to central schools as to not require transportation services. A high percentage of pupils transported indicated areas with a relative absence of large centers of population, where walking to school was feasible, and a high degree of centralization, or both. Variations in this measure might result from changes in school organization affecting the number of statutory transported pupils but otherwise the measure was relatively independent of school board policies.

STATISTICAL TREATMENT OF DENSITY MEASURES

Fourteen measures of density were selected for this study in Chapter II. The values of each measure for the year 1961 were calculated for each division and county in Alberta and shown in Tables II, page 58, Table III, page 64, and Table IV, page 70.

This section presents the statistical treatment applied to the measures. The costs of pupil transportation and all values of the measures were punched onto cards and programs were designed to enable the various statistical procedures to be performed by the computer.

The first procedure was to calculate coefficients of correlation between the costs of pupil transportation in the divisions and counties and each of the values of the calculated measures. The appropriate program was run through the computer and the values of the coefficients are shown in Table V. In the discussion relating to this table and in succeeding sections of this study, the measures will also be referred to as predictor variables.

Simple Correlations With Costs of Pupil Transportation

From Table V it was evident that pupil-district distance (variable 1) correlated highest with the costs of pupil transportation yielding a coefficient of 0.899. It was, therefore, the best single predictor of costs of pupil transportation. Pupil-average distance (variable 5) yielded the second highest correlation, namely

TABLE V

SIMPLE CORRELATIONS BETWEEN COSTS OF PUPIL TRANSPORTATION AND DENSITY MEASURES

Density Measures	Variable Number	Correlation
Pupil - district distance	1	0.899
Pupil - average distance	5	0.882
Bus miles per square mile of organized districts	4	0.569
Acres of organized districts per statutory transported pupil	6	-0.509
Total acreage per unit of population	8	-0.457
Assessed acreage per statutory transported pupil	9	-0.357
Statutory transported pupils per square mile of organized districts	11	0.319
Per cent of pupils transported	14	0.284
Statutory transported pupils per bus operated	13	0.264
Bus miles per transported pupil	2	-0.204
Equalized assessment per statutory transported pupil	12	0.156
Population per square mile of organized districts	10	-0.150
Assessed acreage per unit of population	7	-0.140
Bus miles per statutory transported pupil	3	-0.122

a coefficient of 0.882. The variable that correlated lowest with costs of pupil transportation was bus miles per statutory transported pupil (variable 3) with a correlation coefficient of -0.122. It was, therefore, the least reliable predictor of the costs of pupil transportation.

Since the primary intent of this study was to determine the degree to which the various density measures would predict pupil transportation costs, the correlations shown in Table V were squared to determine the percentage of influence upon costs of pupil transportation accounted for by each measure. It was revealed that the best predictor (variable 1) by itself would account for only 80.8 per cent.

The implication was that more than one variable should be used. To determine which additional measures would assist in increasing the percentage of influence upon costs of pupil transportation which could be accounted for, two additional procedures were undertaken. They were: (1) the establishment of inter-correlations among the measures, and (2) the utilization of the step-wise multiple regression analysis.

Inter-correlations Among Predictor Variables

Inter-correlations among the predictor variables as derived by the computer are recorded in Table VI. The coefficient of correlation between bus miles per statutory transported pupil (column 3) and bus miles per transported pupil (row 2), for example, was found to

TABLE VI

INTER-CORRELATIONS AMONG COSTS AND FOURTEEN MEASURES

	C	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Costs of pupil transportation	Weighted average pupil - district distance	Bus miles per transported pupil	Bus miles per statutory transported pupil	Bus miles per square mile of organized districts	Pupil - average distance	Acres of organized districts per statutory transported pupil	Assessed acreage per unit of population	Total acreage per unit of population	Assessed acreage per statutory transported pupil	Population per square mile of organized districts	Statutory transported pupils per square mile of organized districts	Statutory transported pupil transported pupil	Statutory transported pupils per bus operated	Per cent of pupil transported
C	1.000	.899	-.204	-.122	.569	.882	-.509	-.140	-.457	-.357	-.150	.319	.156	.264	.284
(1)		1.000	-.357	-.311	.563	.934	-.564	-.254	-.438	-.450	-.091	.390	.051	.456	.280
(2)			1.000	.957	-.205	-.230	.509	.722	-.119	.755	.228	-.534	.453	-.746	.102
(3)				1.000	-.185	-.167	.399	.771	-.139	.730	-.374	-.598	.508	-.795	.089
(4)					1.000	.458	-.676	-.348	-.487	-.567	.397	.767	.105	.434	.264
(5)						1.000	-.512	.073	.447	-.305	-.217	.226	.172	.319	.268
(6)							1.000	.326	.254	.675	-.248	-.562	-.063	-.480	-.032
(7)								1.000	-.131	.860	-.412	-.622	.461	.743	.163
(8)									1.000	.025	-.136	-.318	-.281	.022	-.266
(9)										1.000	-.390	-.724	.333	-.802	.067
(10)											1.000	.738	-.151	.347	-.077
(11)												1.000	-.107	.707	.099
(12)													1.000	.281	-.261
(13)														1.000	.125
(14)															1.000

be 0.957. This high coefficient of correlation indicated that these measures were closely related to each other and, to a large degree, measured the same or similar influences upon costs of pupil transportation. The low correlation coefficient, on the other hand, of 0.051 between equalized assessment per statutory transported pupil (column 7) and the weighted average of pupil-district distance (row 1) indicated little relationship. These variables measured different or dissimilar influences upon costs.

The best single predictor could be readily selected from Table V, page 74. The complex relationships, however, among the density measures as shown in Table VI indicated the necessity to introduce further statistical procedures to select the second, third, fourth and other successive variables to be used collectively for prediction purposes. The third statistical procedure utilized, therefore, was to establish the cumulative predictive values of combinations of measures or variables.

The Step-Wise Selection of Predictors

To identify and establish the order of the density measures as best predictors of the costs of pupil transportation, fourteen separate analyses were made by the computer. The first predictor (pupil-district distance) was selected on the basis that it accounted for a maximum criterion variance. The computer was programmed to select the next best predictor, to be used with the first predictor, on the basis that the second predictor would account for the maximum

amount of the criterion variance remaining after the first predictor had been selected. The process was repeated until all predictor variables were selected in the order of their contribution toward accounting for a maximum of the remaining criterion variance. Thus the method took into account not only the direct relationships between each predictor variable (a density measure) and the criterion (cost) but also those indirect relationships which existed among all predictor variables.

Briefly the method of analysis used for assessing the optimum relationship between the criterion (the costs of pupil transportation) and the fourteen predictor variables (the calculated measures of density) was carried out as outlined by Efroymson.[39] The method was basically one of multiple regression analysis modified to permit optimum prediction with a minimum number of parameters. The method is referred to as a step-wise selection of predictors.

Multiple regression analysis for n predictors required the solution of the weights W_j (j = 1, 2, ... n) for optimum prediction of the criterion C_i (i = 1, 2, ... n). Thus to estimate C_i, by $\hat{C}_i$ when $\hat{C}_i$ was defined by the formula:

$$\hat{C}_i = W_1X_{1i} + W_2X_{2i} + \ldots\ldots\ldots\ldots W_nX_{ni} ,$$

and X_{1i}, X_{2i} $\ldots\ldots\ldots\ldots$ X_{ni} were the predictor variables, required the sum of the squares, S, to be minimized under the condition

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[39] M. A. Efroymson, "Multiple Regression Analysis," Chapter 17, Anthony Ralston and Herbert S. Wilf, ed. Mathematical Method for Digital Computers, (New York: John Wiley and Sons, Inc., 1960), pp.191-203.

$$S = \sum_{i=1}^{N} (C_i - \hat{C}_i)^2$$

where N was the number of observations made.

The efficacy of the prediction was determined by the amount of total variance of the criterion that could be accounted for by the weighted sum. It was given by R^2, where R represented the correlation between $\hat{C}_i$ and C_i. The effectiveness of any predictor X_j was assessed by noting the contribution of variable X_j in accounting for the criterion variance.

To illustrate, the density measure pupil-district distance (Table VI, page 76, Column 1) was observed to be most closely correlated with the costs of pupil transportation. Pupil-average distance (Table VI, page 76, Column 5) appeared to be second best. Since it had a correlation of 0.934 with pupil-district distance it would, however, add little to the accuracy of prediction if used with pupil-district distance. To select the second best predictor, the procedure of the step-wise multiple regression analysis permitted the computer to select the variable with a high correlation with costs of pupil transportation but a low correlation with pupil-district distance.

The process was repeated fourteen times by the computer and variables were arranged in rank order of best to poorest additional predictors. The results are listed in Table VII. The proportion of criterion variance accounted for by each variable or measure and the cumulative total as each additional variable was added are also shown.

TABLE VII

RANK ORDER OF VARIABLES OBTAINED BY THE STEP-WISE MULTIPLE REGRESSION ANALYSIS

Rank Order (k)	Variable Number	Name of Variable	Proportion Remaining Variance Accounted	Cumulative Total of Variance Accounted
1	1	Pupil-district distance	.8086	.8086
2	3	Bus miles per statutory transported pupil	.0276	.8362
3	2	Bus miles per transported pupil	.0121	.8483
4	11	Statutory transported pupils per square mile of organized districts	.0091	.8574
5	13	Statutory transported pupils per bus operated	.0070	.8644
6	5	Pupil-average distance	.0064	.8708
7	7	Assessed acreage per unit of population	.0068	.8776
8	10	Population per square mile of organized districts	.0041	.8817
9	8	Total acreage per unit of population	.0024	.8841
10	6	Acres of organized districts per statutory transported pupil	.0024	.8865
11	9	Assessed acreage per statutory transported pupil	.0011	.8876
12	14	Per cent of pupils transported	.0001	.8877
13	12	Equalized assessment per statutory transported pupil	.0001	.8879
14	4	Bus miles per square mile of organized districts	.0000	.8879

Note: The cumulative total is the squared multiple correlation between the "k" predictors selected and the variable. The multiple correlation between the criterion variable and the predicted criterion can be obtained by taking the square root in the cumulative total column. For example, with four predictors the correlation between the criterion observed and the predicted is the square root of 0.8574 or 0.926.

The step-wise multiple regression anlaysis illustrated again that pupil-district distance (variable 1) was the best predictor of costs of pupil transportation. This variable, as shown in Table VII, accounted for 0.8086 of the variance between actual and predicted costs of pupil transportation. The second best predictor was bus miles per statutory transported pupil (variable 3) which accounted for an additional 0.0276 of the remaining variance. If these two variables were used in a regression equation they would account for a combined variance of 0.8362. The first four variables selected in rank order would account for a combined variance of 0.8574. If all fourteen variables were used they would account for 0.8879 of the criterion variance.

It should be noted from Table VII that, of the five best variables selected in the step-wise multiple regression analysis, the first three of them were Group I measures, i.e. those measures involving distances as one of the factors in the measure. This indicated that measures of this type were most significantly related to the costs of pupil transportation and, therefore, were the best to use for predicting pupil transportation costs. Of the Group II measures, i.e. those involving area as one factor in the measure, only statutory transported pupils per square mile of organized districts was among the best five predictors. One measure from Group III, namely, statutory transported pupils per bus operated ranked among the five best predictors of pupil transportation costs. It was rather

interesting to note that bus miles per square mile of organized districts, a measure involving distances and area but not pupils, was the poorest predictor of pupil transportation costs as determined by the procedure used in the step-wise selection of predictors.

SUMMARY

This chapter provided an outline of the nature of the required data, its sources, and its organization into suitable form for this study. All data were applicable to the 1961 fiscal year.

The fourteen density measures which were selected for further consideration were described and their derivation from the basic data was explained. Their numerical values were calculated and shown in tables. The significance of the calculated numerical values of each of the density measures was discussed.

The statistical treatment of the density measures and the resultant findings illustrated the single variables that have the greatest value as predictors of costs of pupil transportation. The inter-correlations among predictor variables illustrated those variables that measured the same or similar influences on costs of pupil transportation. Their values were shown in tables and their meanings were illustrated. The procedure of the step-wise multiple regression analysis was explained and its application to the measures used in this study considered. The rank order of predictors obtained by the step-wise selection of predictors was shown in tables and the

meanings discussed.

The findings indicated that pupil-district distance was the best single predictor variable from which to predict the costs of pupil transportation in Alberta school divisions and counties. If used in a regression equation this measure would account for 0.8086 of all determinants of costs of pupil transportation. If a higher proportion of the criterion variance were to be measured, more than one variable would have to be used. The additional four variables, in rank order, that could be used to increase the proportion of variance were bus miles per statutory transported pupil, bus miles per transported pupil, statutory transported pupils per square mile of organized districts, and statutory transported pupils per bus operated.

Of the five best predictors selected by the step-wise multiple regression analysis, the best three were measures involving distances as one of the factors in the measures. One measure involving area and one involving pupil load carried by buses were also among the best five predictors that could be used in accounting for additional criterion variance.

The measure involving both distances and area (bus miles per square mile or organized districts), which excluded pupils as a factor, was found to be the poorest predictor of pupil transportation costs when used with other predictors.

CHAPTER IV

APPLICATION OF FINDINGS

The introductory chapter of this study suggested that some means for calculating standardized costs of pupil transportation for inclusion in the Foundation Program in Alberta was necessary. Chapter II revealed several factors that could be used to obtain measures of density and developed the measures that should be tested statistically for their relationships with the costs of pupil transportation. These measures were derived and calculated in Chapter III from the basic data in Appendix B, Tables XII, XIII, and XIV. The findings resulting from the statistical treatment illustrated the order in which these measures could be used in a regression equation or equations for calculating standardized costs of pupil transportation in Alberta from 1961 operational data.

The findings obtained from a step-wise multiple regression analysis of the measures shown in Table VII, page 80, illustrate the relationships between the measures and the costs of pupil transportation as they applied to the province as a whole. Thus, in the province in general, pupil-district distance (variable 1) accounted for about 80 per cent of all influences on the costs of pupil transportation but not necessarily in any particular division or county. The incidence of influences measured by the variables may well differ from one division or county to another.

To further explore the suitability of the density measures, in

a province where great variations exist in numbers and scatter of population and in distances over which pupils are conveyed, it was necessary to develop the findings in Chapter III into regression equations. These equations were intended to reveal the financial effects upon each division and county of the application of the various measures in combinations.

Hence, this chapter will develop several regression equations using combinations of variables selected from Table VII, page 80. Equations will be applied to the data for each division and county to compute shareable costs of pupil transportation which could thus be derived for inclusion in a Foundation Program. These derived, or calculated costs of pupil transportation will then be compared with actual costs to appraise the effects of the application of the regression equations to each division and county. The effect of using the best equation will be examined in terms of the mill rate on equalized assessment and in terms of general foundation program principles.

THE REGRESSION EQUATIONS

When the density measures were analyzed by the computer the "weights" or constants needed to obtain the regression equations were provided in the print-out sheets. A brief elaboration of the procedure by which these constants were obtained is given below.

The solution of the "weights", W_j, involved substituting

the linear sum of $\hat{C}_i$ into the standardized equation given previously on page 79, namely

$$S = \sum_{i=1}^{N} (C_i - \hat{C}_i)^2 ,$$

expanding the equation, and setting the derivatives dS/dW_j to zero ($j = 1, 2, \ldots n$). The solution of W in matrix terms for N observations may be given by the formula:

$$W = R^{-1} P,$$

where W was the column vector of the weight, R^{-1} was the inverse of the correlation between predictors, and P was the column vector containing the correlation between all predictors and the criterion.

A more direct solution might have been obtained by inverting R which contained all predictor-predictor and predictor-criterion intercorrelations. In this instance $1 - \frac{1}{r_{cc}}$, where r_{cc} was the diagonal element of R^{-1} for the criterion row and column, was the squared multiple correlation. In the process of solving R^{-1} (a system of linear equations) a solution for optimum predictor variables could be made.

The Equations

Making use of the inter-correlations among the various predictor variables given in Table VI, page 76, the step-wise multiple regression analysis gave the constants in readily usable form. When

these constants were substituted into appropriate equations the regression equations containing any number of variables from one to fourteen were obtained. Only the first eight equations, using from one to eight variables, will be given here.

The basic form of equation used was $Y = AX_1 + BX_2 + CX_3 + \ldots\ldots\ldots\ldots\ldots + MX_n + R$, where Y was the predicted costs of pupil transportation, A, B, C, ... M, and R were the constants obtained from the computer print-out, and X_1, X_2, X_3, ... X_n were the measures developed for use in this study as predictors of the costs of pupil transportation. These variables are referred to by number rather than by name and correspond to the variable numbers listed in Table VII, page 80.

The resulting equations were:

1. $Y = 9.74X_1 + 35{,}066.6$, if <u>one</u> best predictor (variable 1) were used;
2. $Y = 10.33X_1 + 14{,}062.2X_2 - 1{,}486.4$, if <u>two</u> best predictors (variables 1 and 3) were used;
3. $Y = 10.05X_1 + 43{,}195.5X_2 - 30{,}261.9X_3 + 3{,}666.7$, if <u>three</u> best predictors (variables 1, 3, and 2) were used;
4. $Y = 9.99X_1 + 54{,}678.8X_2 - 36{,}586.5X_3 + 10{,}894.9X_4 - 14{,}821.9$, if <u>four</u> best predictors (variables 1, 3, 2, and 11) were used;
5. $Y = 9.99X_1 + 45.414.4X_2 - 34{,}695.7X_3 + 15{,}068.7X_4 - 1{,}126.7X_5$ 27,219.6, if <u>five</u> best predictors (variables 1, 3, 2, 11, and 13) were used;

6. $Y = 7.29X_1 + 42,104.7X_2 - 33,119.3X_3 + 17,697.3X_4 - 1,165.4X_5 + 2.5X_6 + 22,709.9$, if six best predictors (variables 1, 3, 2, 11, 13, and 5) were used;

7. $Y = 6.63X_1 + 46,558.7X_2 - 32,619.3X_3 + 16,291.3X_4 - 1,475.1X_5 + 3.2X_6 - 149.1X_7 + 37,238.8$, if seven best predictors (variables 1, 3, 2, 11, 13, 5, and 7) were used; and

8. $Y = 6.15X_1 + 34,362.2X_2 - 22,074.4X_3 + 28,237.8X_4 - 1,805.7X_5 + 3.2X_6 - 149.2X_7 - 814.9X_8 + 49,933.1$, if eight best predictors (variables 1, 3, 2, 11, 13, 5, 7, and 10) were used.

In the same way the remaining six equations could have been written out. It was felt that using more than eight variables in a regression equation to compute the predicted costs of pupil transportation would be unwieldy and unnecessary. The addition of six more variables, moreover, would not significantly increase the accuracy of prediction since they would account for an additional cumulative variance of only 0.0062. From Table VII, page 80, it may be noted that the first eight variables account for a cumulative variance of 0.8817; the use of the remaining six variables would increase the cumulative variance to 0.8879.

Application of Equations to Divisions and Counties

Only six of the regression equations will be tested for particular application to the divisions and counties. These equations

which will illustrate the prediction of costs of pupil transportation using density measures, will include one, two, three, four, five and eight variables, respectively.

Substitution of the numerical values of the measures from Tables II, page 58, Table III, page 64, and Table IV, page 70, into the regression equations gave the calculated costs of pupil transportation in each division and county. The values of these calculated costs are shown in Table VIII. Column (1) shows the name and number of the divisions and counties, Column (2) shows the 1961 costs of pupil transportation, and Column (3) shows the total grants received for pupil transportation, including special grants for special cases. Subsequent columns show the calculated costs of pupil transportation using the respective regression equations. Column (4) shows the calculated costs when the equation with one best predictor variable was used. Column (5) shows the calculated costs when the equation with the two best variables was used. Similarly, Column (6) shows the calculated costs when the equation with three best predictor variables was used; Column (7), when four best predictor variables used; Column (8), when five best predictor variables used; and Column (9) when eight best predictor variables were used.

Table VIII, Column (4) shows that if one best variable, pupil-district distance, were used in the equation for predicting the costs of pupil transportation twenty-two divisions and counties would be entitled to amounts that are at least $10,000 less than the amounts

TABLE VIII

COSTS, GRANTS AND CALCULATED COSTS

Division or County Name and Number (1)		Costs of pupil transportation (2)	Grants for pupil transportation (3)	Calculated costs of pupil transportation using: One best predictor variable (4)	Two best predictor variables (5)	Three best predictor variables (6)	Four best predictor variables (7)	Five best predictor variables (8)	Eight best predictor variables (9)
Berry Creek	1	$ 45,566	$ 37,730	$ 64,672	$ 72,033	$ 44,210	$ 35,074	$ 34,149	$ 37,817
Cardston	2	125,835	118,538	134,574	134,142	128,875	125,127	129,622	133,532
Medicine Hat	4	188,005	154,510	161,333	154,928	159,672	147,806	160,565	160,145
Taber	6	126,138	168,625	182,666	178,397	180,489	166,800	171,153	178,516
Lethbridge	7	202,592	153,305	170,624	165,063	170,241	175,990	187,587	196,862
Acadia	8	133,057	89,472	101,526	129,747	124,180	127,522	125,085	130,562
Sullivan Lake	9	95,396	50,909	74,317	81,344	87,206	86,540	90,005	91,959
Peace River	10	168,735	191,439	196,642	182,954	184,228	175,321	183,965	182,441
Lac Ste Anne	11	229,317	170,010	193,037	193,052	199,063	200,473	201,817	204,288
Edson	12	189,881	182,506	190,835	188,185	193,857	192,438	183,327	185,986
Rocky Mountain	15	134,622	147,974	163,164	157,855	154,717	153,465	145,773	140,821
Neutral Hills	16	92,564	58,411	84,911	104,954	108,005	111,363	108,719	111,812
Lamont	18	189,500	202,333	214,061	212,818	212,375	215,806	210,261	204,452
Vegreville	19	223,167	211,095	218,020	220,252	218,830	217,556	216,998	214,665
Camrose	20	208,558	251,255	253,847	255,014	254,033	256,449	256,387	251,903
Two Hills	21	205,723	169,723	173,125	171,935	168,844	171,311	171,747	196,243
Killam	22	189,396	167,448	181,897	183,769	188,384	187,845	186,023	176,207
Stony Plain	23	284,270	255,471	252,649	249,103	250,949	252,668	254,800	245,407
Vermilion	25	263,232	197,997	207,649	210,659	210,633	217,667	212,999	227,222
MacLeod	28	167,671	139,051	157,557	177,782	164,558	164,172	165,770	180,463
Pincher Creek	29	94,330	108,013	129,651	135,389	133,678	132,918	130,972	133,344
Drumheller	30	105,011	80,200	105,626	116,799	124,910	129,314	129,763	117,452
Wainwright	32	153,236	118,567	138,360	147,017	155,455	156,437	152,249	151,317
Provost	33	143,968	88,253	111,910	125,292	129,142	130,933	128,545	116,531
Red Deer	35	312,218	333,152	321,451	322,917	315,152	312,352	308,703	299,434
Westlock	37	187,295	203,780	214,635	211,560	216,129	216,080	223,387	214,593
Foothills	38	155,312	143,785	158,109	162,196	163,267	164,507	164,934	166,235
Calgary	41	227,646	243,735	247,899	253,488	245,333	232,140	243,333	242,154
Bonnyville	46	232,077	218,320	234,276	235,805	224,973	224,952	219,008	221,213
Spirit River	47	161,219	176,853	187,172	184,864	183,938	180,290	174,566	172,880
High Prairie	48	170,696	198,445	206,371	196,507	196,031	190,529	192,627	180,826
Leduc	49	257,045	227,125	233,933	227,285	228,315	228,184	223,418	224,583

TABLE VIII (Continued)

Division or County Name and Number (1)		Costs of pupil transportation (2)	Grants for pupil transportation (3)	Calculated costs of pupil transportation using: One best predictor variable (4)	Two best predictor variables (5)	Three best predictor variables (6)	Four best predictor variables (7)	Five best predictor variables (8)	Eight best predictor variables (9)
Fairview	50	$115,539	$134,955	$149,883	$147,992	$148,832	$145,949	$150,006	$151,277
Lac La Biche	51	129,547	84,393	105,389	91,377	101,212	97,285	99,363	101,635
Fort Vermilion	52	49,959	28,612	56,724	34,435	31,257	48,523	30,991	32,474
East Smoky	54	64,568	56,793	83,530	73,115	82,881	85,234	77,850	74,938
Red Deer Valley	55	20,987	24,523	56,800	32,673	19,982	23,155	20,954	22,517
Three Hills	60	183,151	149,333	165,420	171,637	178,415	181,737	187,390	190,296
Northland	61	15,190	12,035	24,335	16,484	20,823	19,581	12,655	17,447
Counties									
Grande Prairie	1	195,615	214,559	217,010	209,759	210,635	204,651	201,983	200,164
Vulcan	2	211,462	185,944	190,150	205,740	198,557	196,228	198,804	197,194
Ponoka	3	167,919	204,764	209,471	200,779	202,577	203,716	207,393	221,036
Newell	4	123,681	151,721	172,911	168,754	166,199	162,529	169,844	146,142
Warner	5	153,089	115,342	134,213	139,103	137,048	134,617	136,994	135,375
Stettler	6	169,908	136,835	151,827	161,018	165,460	166,770	170,552	169,004
Thorhild	7	114,560	124,878	144,821	133,197	131,610	130,905	114,929	119,005
Forty Mile	8	189,071	141,174	154,463	173,376	178,489	178,796	177,203	169,673
Beaver	9	190,544	188,505	200,112	201,259	196,721	195,933	197,190	208,606
Wetaskiwin	10	216,520	203,011	235,529	228,415	222,181	222,111	215,582	209,915
Barrhead	11	144,544	167,534	180,705	172,802	173,992	173,686	170,731	170,185
Athabasca	12	264,981	222,386	226,875	235,690	240,185	240,508	243,089	244,518
Smoky Lake	13	144,936	118,365	139,106	134,448	138,188	142,000	136,576	138,308
Lacombe	14	203,408	195,806	197,074	193,819	193,995	204,068	207,376	214,190
Sturgeon	15	225,388	169,558	186,119	174,466	174,013	188,710	192,350	208,504
Wheatland	16	181,909	149,192	165,610	175,214	172,636	171,480	170,870	165,500
Mountain View	17	258,816	246,989	250,158	255,743	252,982	252,686	253,507	255,867
Paintearth	18	138,000	108,521	130,432	146,202	156,680	161,616	159,614	149,816
St. Paul	19	233,025	177,542	191,015	189,783	192,008	194,261	195,682	200,261
Strathcona	20	221,880	184,621	196,602	184,177	186,864	207,112	200,854	209,130
TOTALS		10,001,476	9,155,926	9,982,788	10,003,562	9,990,065	10,023,881	9,988,594	10,114,842

spent on the operation of their respective transportation systems in 1961. On the other hand, twenty divisions and counties would be entitled to amounts greater by at least $10,000 than their costs. The extent of the excess of calculated costs over actual costs would run as high as $56,000 in one extreme case; the excess of actual costs over calculated costs would run as high as $56,000. At the same time seventeen divisions and counties would be entitled to amounts that are approximately within $10,000 of the actual costs.

Using two best variables Table VIII, Column (5) shows that eighteen divisions and counties would be entitled to amounts that are at least $10,000 less than costs; twenty-two would be entitled to amounts at least $10,000 greater than their costs; and nineteen would be entitled to amounts approximately within $10,000 of their actual costs. In this case the excess of actual costs over calculated costs and vice versa would be approximately $50,000.

When the three best variables were used in the regression equation, Table VIII, Column (6) sixteen divisions and counties would be entitled to amounts that are at least $10,000 less than costs; twenty-one would be entitled to amounts which are at least $10,000 greater than costs; and twenty-two would be entitled to amounts approximately within $10,000 of actual costs. The extent of the variation in the greatest excess and the greatest deficiency would be approximately $50,000 in extreme cases.

With four of the best variables used in a regression equation Table VIII, Column (7) shows that there would be fifteen divisions and

counties entitled to amounts that are at least $10,000 less than costs; seventeen that would entitled to amounts that are at least $10,000 greater than costs; and twenty-seven would be entitled to amounts that are within approximately $10,000 of the actual costs. The range of variation would be from $40,000 above costs to $45,000 below costs.

When five of the best variables were used in a regression equation Table VIII, Column (8) shows that there would be twenty-one divisions and counties that would be entitled to amounts that are at least $10,000 less than costs; seventeen that would be entitled to amounts that are at least $10,000 greater than costs; and twenty-one that would be entitled to amounts that are within approximately $10,000 of actual costs. The range of variation would be from $45,000 above costs to $51,000 below costs.

Lastly, with eight of the best variables used in a regression equation, Table VIII, Column (9) there would be nineteen divisions and counties that would be entitled to amounts that are at least $10,000 less than costs; nineteen that would be entitled to amounts that are at least $10,000 greater than costs; and twenty-one that would be entitled to amounts that are within approximately $10,000 of the actual costs. The range of variation would be from $50,000 above costs to $36,000 below costs.

THE SELECTION OF THE BEST EQUATION

The above observations, for further clarification, are

summarized in Table IX. From this table the conclusion could be made that the use of the equation containing four best predictor variables would result in the greatest number of divisions and counties being entitled to amounts of money for pupil transportation that would be within $10,000 of actual costs. At the same time there would be the fewest divisions and counties that would be entitled to amounts either greater or less than their costs of pupil transportation by at least $10,000.

TABLE IX

SUMMARY OF OBSERVATIONS REGARDING CALCULATED AND ACTUAL COSTS

Number of predictor variables in regression equation (1)	Number of divisions and counties where actual costs exceed calculated costs in excess of $10,000 (2)	Extent of excess of actual costs over calculated costs (3)	Number of divisions and counties where calculated costs exceed actual costs in excess of $10,000 (4)	Extent of excess of calculated costs over actual costs (5)	Number of divisions and counties where calculated costs are within $10,000 of actual costs (6)
1	22	$56,000	20	$56,000	17
2	18	50,000	22	50,000	19
3	16	50,000	21	50,000	22
4	15	45,000	17	40,000	27
5	21	51,000	17	45,000	21
8	19	36,000	19	50,000	21

Appraisal in Terms of Mill Rate

To further explore the effect that the use of the regression equation containing four best predictor variables would have on shareable pupil transportation costs in each division and county another calculation was made. The procedure was necessary, in view of the wide variation in equalized assessments in the divisions and counties, to express the differences between predicted and actual costs of pupil transportation as a mill rate on equalized assessment.

Translating the differences between calculated and actual costs of pupil transportation into a mill rate on equalized assessment would give an indication of the additional tax effort, beyond the Foundation Program requirements, that would be required in each division and county. A positive value will indicate those divisions and counties that would be required to levy an additional mill rate; a negative value will indicate those that could decrease their mill rate below the requirements of the Foundation Program.

Table X lists the divisions and counties in Column (1) and shows the 1961 pupil transportation costs in Column (2). Column (3), which was calculated from the regression equation containing four best predictor variables, indicates the predicted costs. Column (4) shows the differences, in dollars, between the calculated and the actual costs of pupil transportation and was obtained by subtracting Column (2) from Column (3). Column (5) is the equalized assessment

TABLE X

DIFFERENCES BETWEEN ACTUAL AND CALCULATED COSTS USING FOUR VARIABLES TRANSLATED INTO MILL RATES ON EQUALIZED ASSESSMENTS

Division or County Name and Number (1)		Costs of Pupil Transportation (2)	Calculated Costs Using Four Variables (3)	Difference Between Calculated and Actual Costs (4)	Equalized Assessment (5)	Mill Rate On Equalized Assessment (6)
Berry Creek	1	$ 45,566	$ 35,074	$-10,492	$ 3,949,371	+2.65
Cardston	2	135,835	125,127	-10,708	11,941,782	+0.90
Medicine Hat	4	188,005	147,806	-40,199	6,462,034	+6.22
Taber	6	126,138	166,800	+40,662	12,315,950	-3.30
Lethbridge	7	202,592	175,990	-26,602	12,586,043	+2.11
Acadia	8	133,057	127,522	- 5,535	7,050,955	+0.78
Sullivan Lake	9	95,396	86,540	- 8,856	4,076,338	+2.17
Peace River	10	168,735	175,321	+ 6,586	8,392,845	-0.78
Lac Ste Anne	11	229,317	200,473	-28,884	7,446,338	+3.87
Edson	12	189,881	192,478	+ 2,557	16,353,961	-0.16
Rocky Mountain	15	134,622	153,465	+18,843	4,380,386	-4.30
Neutral Hills	16	92,564	111,363	+18,799	4,670,031	-4.02
Lamont	18	189,500	215,806	+26,306	12,291,083	-2.14
Vegreville	19	223,167	217,556	- 5,601	12,782,617	+0.44
Camrose	20	208,558	256,449	+47,891	14,948,145	-3.20
Two Hills	21	205,723	171,311	-34,412	9,203,904	+3.74
Killam	22	189,396	187,845	- 1,551	12,471,977	+0.12
Stony Plain	23	284,270	252,668	-31,602	21,625,765	+1.46
Vermilion	25	263,232	217,667	-45,565	17,520,165	+2.60
MacLeod	28	167,671	164,172	- 3,499	16,875,537	+0.21
Pincher Creek	29	94,330	132,918	+38,588	9,161,601	-4.21
Drumheller	30	105,011	129,314	+24,303	6,899,949	-3.52
Wainwright	32	153,236	156,437	+ 3,201	10,475,926	-0.31
Provost	33	143,968	130,933	-13,035	7,279,795	+1.79
Red Deer	35	312,218	312,352	+ 134	19,010,944	-0.01
Westlock	37	187,295	216,080	+28,785	9,409,992	-3.05
Foothills	38	155,312	164,507	+ 9,195	13,255,212	-0.69
Calgary	41	227,646	232,140	+ 4,494	19,384,299	-0.23
Bonnyville	46	232,077	224,952	- 7,125	4,365,350	+1.63
Spirit River	47	161,219	180,290	+19,071	6,497,430	-2.93
High Prairie	48	170,696	190,529	+19,833	7,063,496	-2.80

TABLE X (Continued)

Division or County Name and Number		Costs of Pupil Transportation	Calculated Costs Using Four Variables	Difference Between Calculated and Actual Costs	Equalized Assessment	Mill Rate On Equalized Assessment
(1)		(2)	(3)	(4)	(5)	(6)
Leduc	49	$257,046	$228,184	-28,862	$21,976,090	+1.31
Fairview	50	155,539	145,949	+30,410	5,411,837	-5.61
Lac La Biche	51	129,547	97,285	-32,262	1,959,120	+16.47
Fort Vermilion	52	49,959	48,528	- 1,431	379,322	+0.38
East Smoky	54	64,568	85,234	+20,666	1,736,697	-10.99
Red Deer Valley	55	20,987	23,155	+ 2,168	962,852	-2.25
Three Hills	60	183,151	181,737	- 1,414	14,946,903	+0.09
Northland	61	15,190	19,581	+ 4,391	603,682	-7.19
Counties						
Grande Prairie	1	195,615	204,651	+ 9,036	9,640,841	-0.94
Vulcan	2	211,462	196,228	-15,234	17,886,782	+0.85
Ponoka	3	167,919	203,716	+35,797	13,892,576	-2.57
Newell	4	123,681	162,529	+38,848	7,811,177	-4.97
Warner	5	153,089	134,617	-18,472	12,597,889	+1.46
Stettler	6	169,908	166,770	- 3,138	10,720,783	+0.29
Thorhild	7	114,560	130,905	+16,345	8,051,085	-2.03
Forty Mile	8	189,071	178,796	-10,275	12,549,901	+0.81
Beaver	9	190,544	195,933	- 5,389	11,670,965	+0.41
Wetaskiwin	10	216,520	222,111	+ 5,591	10,839,178	-0.52
Barrhead	11	144,544	173,686	+29,142	6,055,254	-4.81
Athabasca	12	264,981	240,508	-24,473	6,006,236	+4.07
Smoky Lake	13	144,936	142,000	- 2,936	5,056,201	+0.58
Lacombe	14	203,408	204,068	+ 660	19,739,341	-0.03
Sturgeon	15	225,388	188,710	-36,678	11,513,268	+3.18
Wheatland	16	181,909	171,480	-10,429	14,914,221	+0.70
Mountain View	17	258,816	252,686	- 6,130	17,723,980	+0.35
Paintearth	18	138,000	161,616	+23,616	7,608,084	-3.10
St. Paul	19	233,025	194,261	-38,764	5,676,240	+6.82
Strathcona	20	221,880	207,112	-14,768	36,209,620	+0.39

of each division and county. Column (6) was calculated by converting the differences between calculated and actual costs of pupil transportation to mill rates based upon equalized assessment.

Observation of Table X shows that in six divisions and counties, out of a total of fifty-nine, the difference between calculated and actual costs of pupil transportation would be reflected in rate increases or decreases of five mills or more. In three of these divisions and counties, calculated costs exceeded actual costs of pupil transportation. The school authorities in these divisions and counties might use surplus revenues for improving their services or they might decrease their mill rates below Foundation Program requirements. In the other three cases, actual costs exceeded calculated costs of pupil transportation. The school authorities in these divisions and counties would require an additional mill rate beyond Foundation Program requirements. These cases might be special cases and as such might require special consideration. However, the policies and practices of these school authorities would first require careful study to determine whether pupil transportation costs beyond those recognized for inclusion in the Foundation Program were attributable to conditions beyond their control.

Graphic Representation of Effect

Figure 2 further illustrates the relationships between calculated and actual costs of pupil transportation in each division

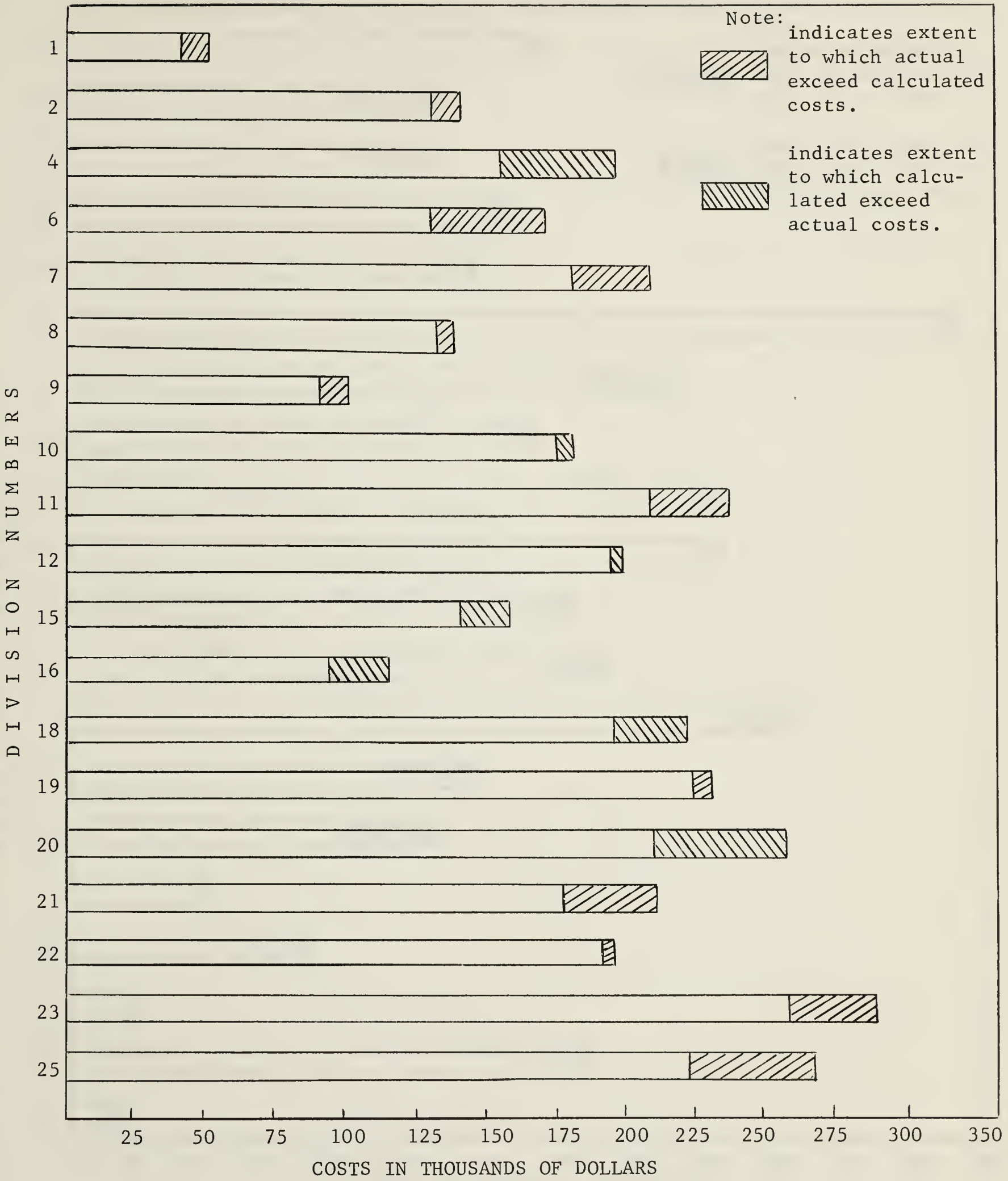

FIGURE 2

RELATIONSHIP BETWEEN ACTUAL AND CALCULATED COSTS USING FOUR VARIABLES

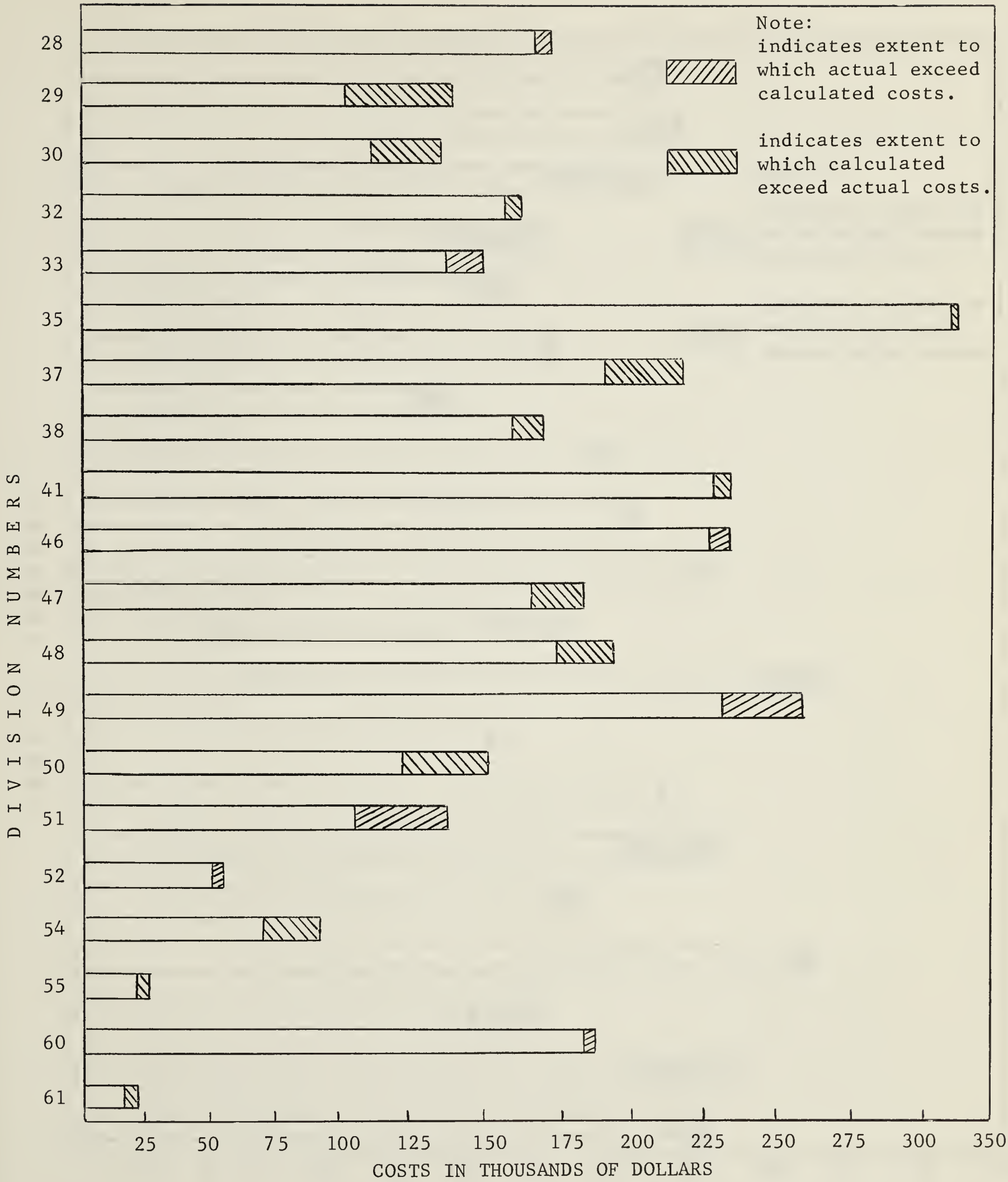

FIGURE 2 (Continued)

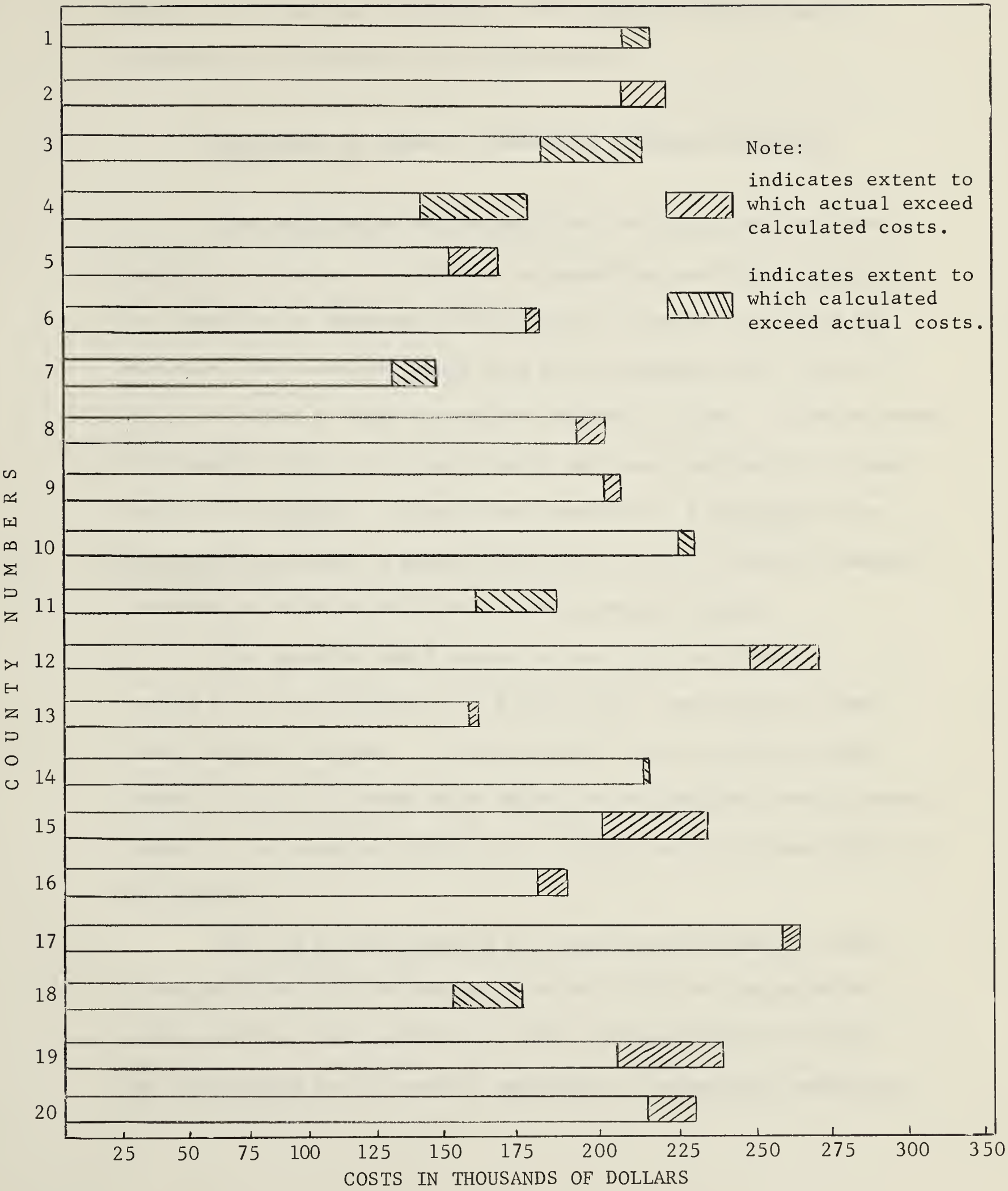

FIGURE 2 (Continued)

and county using four variables. The shaded portions indicate graphically the extent of the differences.

EVALUATION IN TERMS OF FOUNDATION PROGRAM PRINCIPLES

The application of the equation containing the four best predictor variables, in addition to providing sufficient funds for the operation of adequate transportation services in most of the divisions and counties, would also be in agreement with the principles on which a sound foundation program is based. It would assure a foundation level of transportation services required for a sound educational program. It would not provide for a maximum service but would constitute a guaranteed level of costs of pupil transportation below which no division or county should operate.

The equation would ensure an equitable and adequate method for the distribution of funds raised from provincial and local taxation sources. It would provide for each division and county a source of funds on an objective yet realistic basis having regard to the numerous differences existing in the various parts of the province.

The use of the equation for distributing funds for pupil transportation would encourage sound and efficient organization, administration, and operation of pupil transportation services. The funds would not be used to subsidize or perpetuate inefficient

or unnecessary practices, nor would they encourage uneconomical or inefficient procedures in school organization. At the same time the use of the equation would not limit local initiative or restrict the program of education.

The equation calculated from the four best variables would provide a maximum opportunity and encouragement for the development and exercise of local leadership and responsibility in the provision of transportation services. It would allow for the exercise of local leadership where additional centralization of small, ineffective, limited enrolment schools, particularly at the high school level, would be warranted. Such decisions of local school authorities would not be restricted since the costs of the additional transportation services would increase the shareable costs proportionately. In other words, the use of the equation would provide for the recognition of local policies and practices where such policies and practices were justified in the light of local conditions. At the same time, shareable costs calculated by the equation would reflect policies of school authorities in regard to school organization and the number and types of schools that were to be operated.

The equation would be easily adaptable to improvements from time to time as conditions change, as newer data become available annually, or as inequities result. Being based on studies which have taken into consideration pertinent evidence, proven factors affecting

costs of pupil transportation obtained from primary sources, and developed by sound mathematical and statistical procedures it would encourage and facilitate long range planning as contrasted with expedient action or short sighted practices.

Lastly, the equation for calculating the shareable costs of pupil transportation would not restrict or dictate the size of buses to be used, the route to be followed, or the maximum services which a school authority might wish to provide. It would not be primarily a means of controlling costs and there would be no need for restrictive clauses which would limit a school authority to a fixed percentage of previous year's costs. It would be a comprehensive but practical and equitable method of determining the level of pupil transportation costs which would be supported from the Foundation Program Fund.

SUMMARY

This chapter has explored the suitability of fourteen density measures for calculating standardized pupil transportation costs in each division and county in Alberta. Eight regression equations have been developed and calculations of predicted costs based on six of these equations have been made. These calculated costs have been shown in tables and the findings summarized. It has been shown that the five best predictor variables to use (in rank order) in calculating standardized costs of pupil transportation in Alberta were:

(1) pupil-district distance; (2) bus miles per statutory transported pupil; (3) bus miles per transported pupil; (4) statutory transported pupils per square mile of organized districts; and (5) statutory transported pupils per bus operated. The equation based on four of the best predictor variables would give the closest approximation of calculated to actual costs of pupil transportation.

This equation would provide a broader base on which standardized costs could be calculated and would adequately allow for differences which exist in the costs of pupil transportation. The total calculated costs of pupil transportation would be very close to the total actual costs of pupil transportation in Alberta in 1961.

The actual costs of pupil transportation for all divisions and counties in 1961, as noted in the total of Table VIII, page 90, Column (2) were $10,001,476 while in the same year the total shareable costs recognized by the Foundation Program for pupil transportation were only $9,155,926, Table VIII, page 90, Column (3). In the year 1961, sixteen divisions and counties received at least $10,000 more than the costs of transportation; thirty-five received at least $10,000 less; and eight divisions and counties received amounts which were within $10,000 of their costs.

The use of the equation with four best predictors would have provided $10,023,881 for pupil transportation as shown in Table VIII, page 90, Column (7) compared to the actual costs of $10,001,476 as shown in Table VIII, page 90, Column (2). Fifteen divisions and counties

would have been entitled to amounts that were at least $10,000 less than their pupil transportation costs; seventeen would have been entitled to amounts that were at least $10,000 in excess of their pupil transportation costs; and twenty-seven would have been entitled to amounts that were within $10,000 of their actual costs. Only three divisions or counties would have required additional levies of more than five mills to meet their deficiencies. The use of this equation would have accounted for approximately eighty-six per cent of the variance between calculated and actual costs of pupil transportation.

The equation using four of the best predictor variables has been evaluated in terms of general foundation program principles and in its effect on the administration of pupil transportation services in the Foundation Program in Alberta.

CHAPTER V

SUMMARY AND CONCLUSIONS

This chapter will summarize briefly some of the important procedures used in, and the findings derived from the study. It will outline the significant contribution of each chapter and summarize the findings. Some recommendations for continuing research will be made.

HIGHLIGHTS OF THE STUDY

The first chapter of this study provided a short review of the growth of pupil transportation services in the rural areas of the province and the conditions that contributed to such a rapid and continuous growth. The scope of pupil transportation services was discussed and illustrated. An analysis was made of the various attempts to provide a measure of assistance to school authorities for pupil transportation prior to the introduction of the Foundation Program in 1961.

Noting the changed conditions in rural education, the factors contributing to such changes, and the advent of a new concept of financing educational costs in Alberta, the purposes of the study were justified.

In addition, this chapter gave a comprehensive outline of the foundation program concept in educational finance. The Foundation

Program in Alberta was discussed, particularly in its application to the calculation of pupil transportation costs. It was shown that the inclusion of pupil transportation costs in the Foundation Program and the use of a separate means for treatment of such costs, apart from instructional costs, were defensible. The pupil transportation regulations in effect during 1961 and 1962 were outlined to illustrate that the treatment of pupil transportation costs was based upon calculation of costs from some expression of "density of population," rather than upon the acceptance of actual expenditures.

Chapter II provided a comprehensive review of related literature dealing with the types of factors, indicators, or measures used for predicting the costs of pupil transportation. It illustrated, through summaries of specific formulae used in four regions of the United States, the general application of such measures for calculating pupil transportation costs in foundation programs.

The selected studies and formulae revealed some of the types of factors which have affected the costs of pupil transportation. These factors were arranged in four classifications, as (1) the numbers of pupils transported, (2) the area served by a pupil transportation system, (3) the policies of school authorities, and (4) the topography of the region. From these factors, in various combinations, fourteen measures were developed for use in this study. These measures were classified into three groups as

(1) those measures based on distances or mileages as one of the factors in the measure, (2) those measures based on area in square miles or in acres as one of the factors in the measure, and (3) other measures, of a miscellaneous nature, involving neither distances nor area as one of the factors in the measure.

Chapter III, the focus of this study, gave the nature of the data required, the sources of the data, the organization of the data into suitable form, and the description and derivation of each of the fourteen measures selected for further consideration in this study. The calculation of each measure from the basic data was illustrated and the statistical treatment applied to the measures was outlined. The significance of the calculated numerical values of each measure was discussed in relation to its application to conditions in Alberta school divisions and counties.

A step-wise multiple regression analysis was used to determine the order of the predictor variables, from best to poorest. Tables were used to indicate the proportion of variance between calculated and actual costs of pupil transportation that would be accounted for by each measure. Cumulative totals indicated the proportion of variance that would be accounted for by using two to fourteen measures in combination.

The findings indicated that pupil-district distance was the best single predictor variable, based on 1961 operational data, from which standardized pupil transportation costs in Alberta school

divisions and counties could be calculated. If used in a regression equation, this measure would account for 0.8086 of the variance between calculated and actual costs of pupil transportation. If a higher proportion of the criterion variance were to be accounted for, it would be necessary to use additional variables in the regression equation. The four best additional variables, in rank order, were bus miles per statutory transported pupil, bus miles per transported pupil, statutory transported pupils per square mile of organized districts, and statutory transported pupils per bus operated.

The results of the statistical procedures have shown that of the five best predictor variables, selected by the step-wise multiple regression analysis, the best three were measures involving distances as one of the factors in the measure. The next best variable involved area as one of the factors in the measure, and the fifth measure involved the pupil load carried by the buses. The measure (bus miles per square mile of organized districts), involving both distance and area but excluding numbers of pupils as a factor in the measure, was found to be the poorest predictor of pupil transportation costs where more than one measure was used in a best order.

Chapter IV further explored the suitability of the density measures for predicting pupil transportation costs in each division and county of Alberta. Eight regression equations were developed,

using from one to eight of the best predictor variables respectively. Six of these equations were used to calculate standardized costs of pupil transportation. These calculated standardized costs of pupil transportation were compared with actual costs in 1961 to reveal discrepancies between standardized and actual costs in each division and county.

Comparisons of calculated and actual costs of pupil transportation illustrated that the regression equation based on four of the best measures would be most appropriate for use in Alberta. Its use, as compared with the use of other equations, resulted in discrepancies between calculated and actual costs of pupil transportation which were less than $10,000 in a maximum number of cases and over $10,000 in a minimum number of cases. The use of this equation, also, provided for the lowest range of differences between actual and standardized costs of pupil transportation in the divisions and counties.

To further explore the effect that the use of the regression equation containing the four best predictor variables would have on shareable pupil transportation costs in each division and county, another evaluation was made. The procedure for this evaluation expressed the differences between calculated and actual costs of pupil transportation as mill rates on equalized assessments. These mill rates gave an indication of the additional tax effort,

beyond Foundation Program requirements, that would be needed in each division or county.

The results of the above procedure indicated that there were six divisions and counties, out of a total of fifty-nine, in which the differences between calculated and actual costs of pupil transportation would be reflected in mill rates of more than plus or minus five mills. In three of these divisions or counties the calculated exceeded the actual costs. School authorities in these areas could use the additional revenue to improve their services or to reduce their mill rates below Foundation Program requirements. In the other three cases, the actual exceeded the calculated costs of pupil transportation. These school authorities would be required to levy mill rates of more than five mills above those required by the Foundation Program.

The equation using the four best predictor variables was further evaluated in terms of general foundation program principles. It was found to be comparatively simple to apply yet sufficiently comprehensive in its measurement of influences upon costs to account for eighty-six per cent of the variance between calculated and actual costs of pupil transportation in Alberta school divisions and counties. It was regarded as a suitable equation to use in calculating standardized pupil transportation costs for the purpose of their inclusion in the Foundation Program Plan in Alberta.

NEED FOR CONTINUING RESEARCH

Throughout this study it was apparent that there was a need for the Department of Education to collect more data on pupil transportation operations in the province. In the study, for instance, several measures of density were not selected for study simply because the data for their derivation were not in departmental files. Information on types of roads on which buses operate, the existence of natural barriers, the extent of uninhabited areas through which buses travel, and the extent of isolated pockets of settlement might be useful in conducting further research into the problems of determining an adequate basis for calculating standardized costs of pupil transportation. Much of the above information could be readily available if attempts were made to collect and compile it in usable form.

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APPENDIX A

BREAKDOWN OF TAXABLE AND EQUALIZED ASSESSMENTS

1961

TABLE XI

BREAKDOWN OF TAXABLE AND EQUALIZED ASSESSMENTS

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
Divisions.		
1. Berry Creek		
Special areas	2,586,837	3,949,371
2. Cardston		
(V) Hillspring	83,079	57,645
(V) Glenwood	143,782	101,235
(T) Cardston	2,741,506	2,075,167
(T) Magrath	1,310,042	961,304
(M.D.) Cardston #6	8,566,737	8,746,431
Total	12,845,146	11,941,782
4. Medicine Hat		
(T) Irvine	281,954	193,836
I.D. #11	4,920,262	5,003,251
I.D. #22	385,992	450,110
Special area #2	841,104	990,083
Total	6,429,312	6,637,280
6. Taber		
(V) Grassy Lake	306,369	197,040
(T) Vauxhall	802,360	625,637
(T) Taber	6,228,934	4,023,377
(M.D.) Taber #14	7,377,310	7,469,896
Total	14,732,973	12,315,950
7. Lethbridge		
(V) Nobleford	530,274	339,632
(T) Picture Butte	1,379,718	880,673
(T) Coaldale	2,329,261	1,486,766
(M.D.) Lethbridge #25	14,704,070	9,878,972
Total	18,943,323	12,586,043

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
8. Acadia		
(V) Cereal	135,169	94,583
(V) Chinook	92,675	66,249
(V) Empress	329,703	236,343
(V) Oyen	164,934	375,125
(M.D.) Acadia	1,704,040	1,757,308
Special area	3,332,681	4,521,347
Total	5,759,202	7,050,955
9. Sullivan Lake		
(V) Youngstown	263,485	170,899
Special areas	3,331,296	3,905,439
Total	3,594,781	4,076,338
10. Peace River		
(V) Berwyn	390,656	231,561
(V) Nampa	237,848	167,392
(T) Grimshaw	1,027,536	655,876
(T) Manning	467,379	352,753
(T) Peace River	2,339,906	1,577,399
(M.D.) Peace #135	2,349,761	2,294,968
I.D. #131	1,733,803	1,177,644
I.D. #138	1,881,398	1,933,970
I.D. #139	6,905	7,059
I.D. #146		4,223
Total	10,405,192	8,392,845
11. Lac Ste. Anne		
(V) Alberta Beach S.V.	511,871	393,355
(V) Castle Island S.V.	31,826	18,883
(V) Onoway	244,914	174,227
(V) Sangudo	341,838	218,922
(V) Sandy Beach S.V.	181,580	101,414
(V) Sunset Point S.V.	102,523	59,545
(V) Whitecourt	792,641	507,332
(T) Mayerthorpe	656,097	469,792
(M.D. Lac Ste. Anne #93	5,122,507	4,967,688
I.D. #109	603,361	535,180
Total	8,589,158	7,446,338

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
12. Edson		
(V) Evansburg	382,787	257,956
(V) Wildwood	378,730	270,431
(T) Edson	3,322,132	2,618,153
(T) Hinton	12,161,524	8,235,643
I.D. #78	2,455,998	2,072,728
I.D. #95	2,460,394	1,904,090
I.D. #96	26,260	24,702
I.D. #109	723,058	549,044
I.D. #79 (re Coal Branch)	659,760	421,214
Total	22,570,643	16,353,961
13. Rocky Mountain		
(V) Caroline	147,854	107,137
(T) Rocky Mountain House	1,648,203	1,217,868
I.D. #58	317,824	324,772
I.D. #65	2,775,850	2,730,609
Total	4,889,731	4,380,386
16. Neutral Hills		
(V) Consort	529,114	393,937
(V) Veteran	254,413	177,736
Special Area #3	3,403,511	4,098,358
Total	4,187,038	4,670,031
18. Lamont		
(V) Andrew	747,995	478,911
(V) Bruderheim	396,523	255,398
(V) Chipman	244,397	173,405
(V) Lamont	709,198	519,985
(T) Mundare	700,513	519,103
(M.D.) Lamont #82	10,430,386	10,344,281
Total	13,229,012	12,291,083

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
19. Vegreville		
(V) Innisfree	420,465	273,012
(V) Lavoy	129,591	92,257
(V) Mannville	759,144	488,061
(V) Minburn	152,633	108,242
(T) Vegreville	3,176,263	2,066,853
(M.D.) Minburn #72	9,870,340	9,754,192
Total	14,508,436	12,782,617
20. Camrose		
(V) Bashaw	742,386	535,527
(V) Bawlf	241,223	170,400
(V) Bittern Lake	80,947	65,657
(V) Edberg	176,480	113,066
(V) Ferintosh	174,300	122,910
(V) Hay Lakes	240,663	168,485
(V) New Norway	218,441	153,925
(M.D.) Camrose #63	14,353,781	13,618,175
Total	16,228,221	14,948,145
21. Two Hills		
(V) Derwent	351,702	251,846
(V) Hairy Hill	251,710	161,144
(V) Myrnam	597,237	382,319
(V) Willingdon	581,864	372,512
(T) Two Hills	1,206,637	770,197
(M.D.) Eagle #81	7,459,166	7,265,886
Total	10,448,316	9,203,904

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
22. Killam		
(V) Heisler	162,938	113,163
(V) Alliance	454,646	318,755
(V) Killam	436,623	319,240
(V) Lougheed	287,128	184,105
(V) Sedgewick	632,606	445,573
(V) Strome	301,964	193,414
(T) Hardisty	609,396	428,195
(T) Daysland	663,556	423,543
(M.D.) Flagstaff #62	10,328,947	10,046,009
Total	13,877,804	12,471,997
23. Stony Plain		
(V) Seba Beach S.V.	415,399	323,607
(V) Betula Beach S.V.	30,705	17,797
(V) Edmonton Beach S.V.	81,359	48,750
(V) Entwistle	302,557	197,092
(V) Kapasiwin S.V.	78,838	56,058
(V) Lakeview S.V.	20,226	15,176
(V) Point Alison S.V.	44,748	33,195
(V) Spruce Grove	635,545	407,222
(T) Stony Plain	1,825,572	1,168,460
(T) Drayton Valley	3,561,157	2,273,084
(M.D.) Stony Plain #84	14,967,550	12,609,304
I.D. #77	5,833,450	4,381,906
I.D. #78	122,172	94,114
Total	27,919,278	21,625,765
25. Vermilion		
(V) Dewberry	224,743	158,634
(V) Kitscoty	313,665	201,737
(V) Marwayne	438,024	313,858
(T) Vermilion	2,980,267	2,266,441
(M.D.) Vermilion River #71	14,778,425	14,579,495
Total	18,735,124	17,520,165

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable assessment in dollars	1961 Equalized assessment in dollars
28. MacLeod		
(T) Claresholm	2,834,102	1,838,871
(T) Fort MacLeod	3,137,373	2,433,122
(T) Granum	397,276	274,368
(T) Stavely	454,811	295,182
(M.D.) Willow Creek #26	10,066,820	10,159,634
Nanton Consol. #50	2,354,137	1,874,360
Total	19,244,519	16,875,537
29. Pincher Creek		
(V) Cowley	130,510	93,079
(T) Pincher Creek	1,899,369	1,406,888
(M.D.) Pincher Creek #49	8,376,176	7,661,634
Total	10,406,055	9,161,601
30. Drumheller		
(V) Craigmyle	165,014	114,523
(V) Delia	395,738	280,585
(V) Morrin	285,290	201,693
(V) Munsen	83,139	53,277
(V) Ramsey	172,180	110,243
(M.D.) Starland #47	6,201,911	6,139,628
Total	7,303,272	6,899,949
32. Wainwright		
(V) Chauvin	325,166	239,804
(V) Edgerton	394,988	252,919
(V) Irma	521,997	368,579
(T) Wainwright	2,894,739	2,192,764
(M.D.) Wainwright #61	7,685,758	7,421,860
Total	11,822,648	10,475,926

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
33. Provost		
(V) Amisk	127,352	90,383
(V) Czar	205,039	131,278
(V) Hughenden	243,469	170,804
(T) Provost	1,030,437	764,150
(M.D.) Provost #52	6,387,397	6,123,180
Total	7,993,694	7,279,795
35. Red Deer		
(V) Bowden	481,003	308,244
(V) Delburne	473,965	347,356
(V) Elnora	207,851	147,785
(V) Penhold	365,272	260,146
(T) Innisfail	2,768,860	1,799,818
(T) Sylvan Lake	1,660,846	1,247,407
(M.D.) Red Deer #55	15,916,089	14,900,187
Total	21,873,886	19,010,944
37. Westlock		
(V) Clyde	236,461	171,745
(T) Westlock	1,856,860	1,341,603
(M.D.) Westlock #92	7,701,375	7,590,160
I.D. #107	322,650	306,484
Total	10,117,346	9,409,992
38. Foothills		
(V) Blackie	251,240	175,359
(V) Cayley	148,708	102,798
(T) Okotoks	1,130,289	726,352
(M.D.) Foothills #31	13,187,963	12,250,703
Total	14,718,200	13,255,212

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
41. Calgary		
(V) Airdrie	527,726	378,025
(V) Biesiker	582,064	373,178
(V) Crossfield	560,922	366,676
(V) Irricana	165,083	117,713
(M.D.) Rocky View #44	19,207,538	18,145,358
I.D. #946	3,672	3,349
Total	21,047,005	19,384,299
46. Bonnyville		
(V) Bonnyville Beach S.V.	21,830	16,607
(V) Glendon	268,774	192,568
(T) Grande Centre	579,879	421,925
(T) Cold Lake	440,821	319,918
(M.D.) Bonnyville #87	2,962,182	2,873,109
I.D. #85	7,625	8,731
I.D. #801	506,403	532,492
Total	4,787,514	4,365,350
47. Spirit River		
(V) Rycroft	522,170	334,824
(V) Wanham	233,677	169,805
(T) Spirit River	739,664	548,483
(M.D.) Smoky River #130	26,173	25,186
(M.D.) Spirit River #133	1,534,523	1,529,131
I.D. #132	2,162,795	2,181,676
I.D. #134	1,722,133	1,708,008
I.D. #139		317
Total	6,941,135	6,497,430

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
48. High Prairie		
(V) Slave Lake	167,081	117,901
(V) Donnelly	236,959	167,618
(V) Girouxville	326,757	226,556
(V) Kinuso	277,748	177,673
(T) High Prairie	1,261,623	963,701
(T) McLennan	365,521	233,312
(M.D.) Smoky River #130	2,932,512	3,009,277
I.D. #124	905,062	795,743
I.D. #125	1,292,235	1,310,610
I.D. #126	58,135	61,105
Total	7,823,633	7,063,406
49. Leduc		
(V) Breton	348,901	224,089
(V) Itaska Beach S.V.	81,321	60,209
(V) New Serepta	257,779	164,912
(V) Thorsby	565,198	363,116
(V) Warburg	306,289	196,679
(T) Calmar	828,885	607,253
(T) Leduc	2,876,554	2,279,859
(M.D.) Leduc #75	21,050,510	18,079,973
Total	26,315,437	21,976,090
50. Fairview		
(V) Hines Creek	546,374	389,927
(T) Fairview	1,325,583	852,764
(M.D.) Fairview #136	2,574,455	2,467,357
(M.D.) Peace #135	28,036	29,822
I.D. #132	15	1,361
I.D. #138	8,103	8,746
I.D. #139	1,521,149	1,661,860
Total	6,003,715	5,411,837

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
51. Lac La Biche		
(T) Lac La Biche	1,105,834	760,534
I.D. #102	1,208,905	1,198,586
Total	2,314,739	1,959,120
52. Fort Vermilion		
I.D. #146	52,670	57,159
I.D. #147	254,489	313,785
I.D. #149	8,620	8,378
Total	315,779	379,322
54. East Smoky		
(T) Valleyview	642,178	487,040
I.D. #126	1,384,078	1,167,467
I.D. #110	118,466	82,190
Total	2,144,722	1,736,697
55. Red Deer Valley		
I.D. #42	1,489,883	962,852
60. Three Hills		
(V) Acme	391,064	274,930
(V) Carbon	527,339	338,293
(V) Trochu	875,627	561,290
(T) Three Hills	1,375,256	1,044,255
(M.D.) KneeHill #48	13,176,644	12,728,135
Total	16,345,930	14,946,903

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
61. Northland		
I.D. #85	15,230	15,506
I.D. #111	3,600	3,761
I.D. #121	10,350	8,819
I.D. #125	38,223	32,772
I.D. #128	47,093	160,324
I.D. #129	17,623	15,896
I.D. #131	55	183
I.D. #143 (re McMurray)	13,425	17,296
I.D. #143	83,640	73,586
I.D. #144	250	246
(T) McMurray	359,286	275,293
Total	588,775	603,682
Counties.		
1. Grande Prairie		
(V) Hythe	630,994	403,828
(V) Sexsmith	432,134	277,249
(V) Wembley	224,845	144,052
(T) Beaverlodge	868,711	645,584
(Cty) Grande Prairie #1	7,968,363	8,170,128
Total	10,125,047	9,640,841
2. Vulcan		
(V) Arrowood	240,723	154,147
(V) Carmangay	378,633	244,150
(V) Champion	422,589	295,292
(V) Milo	260,358	166,729
(V) Lomond	326,281	208,759
(T) Vulcan	1,684,730	1,271,048
(Cty) Vulcan #2	15,004,300	15,546,657
Total	18,317,614	17,886,782

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
3. Ponoka		
(T) Ponoka	5,189,676	3,320,770
(T) Rimbey	1,308,361	832,788
(Cty) Ponoka #3	10,179,898	9,739,018
Total	16,677,935	13,892,576
4. Newell		
(V) Duchess	181,745	129,017
(V) Rosemary	176,230	122,845
(V) Tilley	230,587	160,953
(T) Bassano	792,264	577,204
(Cty) Newell #4	7,259,536	6,821,158
Total	8,640,362	7,811,177
5. Warner		
(V) Coutts	283,148	313,053
(V) Warner	692,302	474,624
(T) Milk River	1,173,582	749,097
(T) Raymond	1,849,828	1,361,189
(Cty) Warner #5	9,765,667	9,699,926
Total	13,764,527	12,597,889
6. Stettler		
(V) Big Valley	410,332	271,384
(V) Botha	131,394	90,763
(V) Donalda	302,926	212,296
(V) Gadsby	142,958	91,579
(V) Rachon Sands S.V.	50,288	34,926
(Cty) Stettler #6	10,886,876	10,019,835
Total	12,412,725	10,720,783

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
7. Thorhild		
(V) Radway	257,841	165,206
(V) Thorhild	427,849	273,945
(T) Redwater	1,353,752	870,436
(Cty) Thorhild #7	7,530,038	6,741,498
Total	9,569,480	8,051,085
8. Forty Mile		
(V) Burdett	180,467	125,870
(V) Foremost	701,485	491,984
(V) Bow Island	994,595	739,571
(Cty) Forty Mile #8	10,536,178	11,192,476
Total	12,412,725	12,549,901
9. Beaver		
(V) Holden	816,427	541,953
(V) Ryley	579,869	381,610
(T) Tofield	933,562	669,176
(T) Viking	1,143,916	730,162
(Cty) Beaver #9	9,716,646	9,348,064
Total	13,190,420	11,670,965
10. Wetaskiwin		
(V) Crystal Springs	114,972	87,942
(V) Ma-Me-O Beach	344,979	252,306
(V) Millet	463,637	298,007
(V) Silver Birch	195,831	107,881
(Cty) Wetaskiwin #10	11,127,728	10,093,042
Total	12,247,147	10,839,178

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
11. Barrhead		
(V) Fort Assiniboine	102,101	71,203
(T) Barrhead	2,903,458	1,853,275
I.D. #108	258,655	252,831
I.D. #109	53,965	54,456
(Cty) Barrhead #11	3,956,587	3,823,489
Total	7,274,766	6,055,254
12. Athabasca		
(V) Boyle	447,473	313,617
(V) Island Lake S.V.	35,760	26,703
(T) Athabasca	1,762,164	1,166,054
I.D. #107	267,309	236,639
I.D. #122	107,060	96,779
(Cty) Athabasca #12	4,168,766	4,166,444
Total	6,788,532	6,006,236
13. Smoky Lake		
(V) Smoky Lake	674,994	489,134
(V) Vilna	445,965	285,685
(V) Warspite	162,076	114,291
(V) Waskatenau	381,553	244,398
(Cty) Smoky Lake #13	3,940,020	3,922,693
Total	5,604,608	5,056,201

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
14. Lacombe		
(V) Alix	685,692	494,070
(V) Bentley	596,818	431,733
(V) Blackfalds	424,109	302,113
(V) Clive	230,452	166,746
(V) Eckville	503,333	359,503
(V) Gull Lake S. V.	157,127	113,845
(V) Mirror	467,843	335,433
(T) Lacombe	4,351,607	2,811,739
(Cty) Lacombe #14	15,588,685	14,724,159
Total	23,005,666	19,739,341
15. Sturgeon		
(V) Gibbons	211,905	136,216
(V) Legal	433,484	322,119
(Cty) Sturgeon River #15	11,833,727	11,054,933
Total	12,479,116	11,513,268
16. Wheatland		
(V) Cluny	208,209	145,156
(V) Hussar	341,384	218,753
(V) Rockyford	209,766	146,634
(V) Standard	336,739	243,123
(T) Gleichen	433,511	321,390
(T) Strathmore	939,812	703,235
(Cty) Wheatland #16	13,584,178	13,135,930
Total	16,053,599	14,914,221

TABLE XI (Continued)

Division or County Name and Number	1961 Taxable Assessment in dollars	1961 Equalized Assessment in dollars
17. Mountain View		
(V) Carstairs	836,857	536,464
(V) Cremona	236,405	151,305
(T) Olds	2,738,822	2,092,584
(T) Didsbury	1,277,543	955,997
(T) Sundre	635,089	405,377
(Cty) Mountain View #17	14,321,608	13,582,253
Total	20,046,324	17,723,980
18. Paintearth		
(V) Halkirk	191,879	122,936
(T) Castor	931,768	594,747
(T) Coronation	859,648	642,545
(Cty) Paintearth #18	6,482,593	6,247,856
Total	8,465,888	7,608,084
19. St. Paul		
(V) Elk Point	814,162	522,675
(Cty) St. Paul #19	5,287,347	5,153,565
Total	6,101,509	5,676,240
20. Strathcona		
(T) Fort Saskatchewan	7,959,957	5,664,170
(Cty) Strathcona #20	37,334,954	30,545,450
Total	45,294,911	36,209,620

APPENDIX B

ORIGINAL DATA

FOR 39 SCHOOL DIVISIONS AND 20 COUNTIES

1961

TABLE XII

ORIGINAL DATA FROM OFFICIAL RETURNS OF SCHOOL AUTHORITIES

Division or County Name and Number		Costs of Pupil Transportation	Grants for Pupil Transportation	Pupil-District Distance		Statutory Transported Pupils		Total Acreage of Organized Districts
				June Term	Dec. Term	June Term	Dec. Term	
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)
Berry Creek	1	$ 45,566	$ 37,730	2,916.5	3,242.2	194	189	1,295,000
Cardston	2	135,853	118,538	9,843.0	10,776.4	1,003	1,079	852,800
Medicine Hat	4	188,005	154,510	12,087.5	14,278.0	979	1,117	1,637,280
Taber	6	126,138	168,625	14,949.1	15,461.1	1,450	1,536	933,760
Lethbridge	7	202,592	153,305	13,644.4	14,327.5	1,892	1,862	665,760
Acadia	8	133,057	89,472	6,233.1	7,708.6	542	640	1,434,720
Sullivan Lake	9	95,396	50,909	3,907.5	4,213.3	435	453	954,400
Peace River	10	168,735	191,439	15,947.0	17,551.5	1,428	1,630	1,014,080
Lac Ste Anne	11	229,317	170,010	15,763.5	16,901.5	1,682	1,843	854,240
Edson	12	189,881	182,506	15,245.0	17,114.0	1,512	1,630	876,920
Rocky Mountain	15	134,622	147,974	12,876.9	13,564.0	1,185	1,233	603,353
Neutral Hills	16	92,564	58,411	5,001.5	5,291.5	467	492	1,015,960
Lamont	18	189,500	202,333	18,197.2	18,647.1	1,659	1,734	612,000
Vegreville	19	223,167	211,095	18,433.4	19,309.1	1,622	1,707	847,520
Camrose	20	208,558	251,255	21,904.3	23,298.6	2,303	2,413	836,108
Two Hills	21	205,723	169,723	15,220.9	12,604.7	1,592	1,600	669,720
Killam	22	189,396	167,448	15,047.3	15,116.5	1,470	1,470	908,820
Stony Plain	23	284,270	255,471	21,376.3	23,780.3	2,090	2,279	754,080
Vermilion	25	263,232	197,997	16,436.2	19,642.2	1,841	2,005	1,234,780
MacLeod	28	167,671	139,051	12,316.0	12,966.0	1,041	1,061	1,075,680
Pincher Creek	29	94,330	108,013	9,409.3	10,163.2	694	748	618,255
Drumheller	30	105,011	80,200	7,112.5	7,442.0	670	715	615,934
Wainwright	32	153,236	118,567	10,437.5	10,865.0	877	905	873,280
Provost	33	143,968	88,253	7,909.5	7,859.4	683	694	860,240
Red Deer	35	312,218	333,152	27,992.9	31,517.9	2,525	2,815	953,000
Westlock	37	187,295	203,780	18,204.7	18,835.0	1,816	1,709	800,480
Foothills	38	155,312	143,785	11,829.5	13,837.5	1,179	1,322	739,200
Calgary	41	227,646	243,735	20,541.0	23,817.0	1,864	2,117	1,019,220
Bonnyville	46	232,077	218,320	20,354.7	20,599.8	2,026	1,959	774,560
Spirit River	47	161,219	176,858	15,109.0	16,378.0	1,478	1,557	938,080

TABLE XII (Continued)

Division or County Name and Number		Costs of Pupil Transportation	Grants for Pupil Transportation	Pupil-District Distance		Statutory Transported Pupils		Total Acreage of Organized Districts
				June Term	Dec. Term	June Term	Dec. Term	
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)
High Prairie	48	$170,696	$198,445	17,502.5	17,715.5	1,563	1,637	904,480
Leduc	49	257,046	227,125	19,605.5	21,635.5	2,220	2,381	859,720
Fairview	50	115,539	134,955	11,089.0	12,838.0	963	1,065	742,080
Lac La Biche	51	129,547	84,393	7,260.0	7,160.0	847	850	676,000
Fort Vermilion	52	49,959	28,612	1,798.5	2,861.0	272	402	668,800
East Smoky	54	64,568	56,793	4,428.5	5,796.5	450	567	277,760
Red Deer Valley	55	20,987	24,523	2,153.9	2,347.5	237	278	40,160
Three Hills	60	183,151	149,333	13,222.5	13,624.5	1,406	1,439	815,840
Northland	61	15,190	12,035	636.0	1,425.0	89	199	1,245,280
Counties								
Grande Prairie	1	195,615	214,559	18,162.0	19,457.0	1,835	1,957	1,093,200
Vulcan	2	211,462	185,944	15,438.9	16,647.3	1,305	1,382	1,254,525
Ponoka	3	167,919	204,764	17,106.1	19,105.9	1,787	1,952	675,920
Newell	4	123,681	151,721	11,514.9	18,108.7	1,267	1,381	798,080
Warner	5	153,089	115,342	10,435.6	9,794.8	1,046	1,001	1,018,440
Stettler	6	169,908	136,835	11,175.9	13,205.4	1,176	1,287	974,860
Thorhild	7	114,560	124,878	11,071.0	11,564.5	1,157	1,222	529,518
Forty Mile	8	189,071	141,174	12,120.8	12,464.7	1,033	1,015	1,790,134
Beaver	9	190,544	188,505	16,647.0	17,392.3	1,620	1,669	804,320
Wetaskiwin	10	216,520	203,011	19,933.0	21,553.7	2,054	2,167	718,546
Barrhead	11	144,544	167,534	14,537.7	15,574.9	1,445	1,531	656,000
Athabasca	12	264,981	222,386	19,327.0	20,244.0	1,768	1,852	1,052,500
Smoky Lake	13	144,936	118,365	10,456.5	11,019.4	1,134	1,171	500,320
Lacombe	14	203,408	195,806	15,199.7	18,783.4	1,767	1,896	691,040
Sturgeon	15	225,388	169,558	15,469.5	15,567.0	2,283	2,370	489,920
Wheatland	16	181,909	149,192	13,419.2	13,378.2	1,274	1,268	1,066,649
Mountain View	17	258,816	246,989	21,380.5	23,450.0	2,016	2,173	945,120
Paintearth	18	138,000	108,521	9,546.5	10,158.0	854	906	823,680
St. Paul	19	233,025	177,542	16,344.1	15,511.5	1,787	1,760	764,400
Strathcona	20	221,880	184,621	15,788.5	17,779.1	1,929	2,200	366,720

TABLE XIII

ORIGINAL DATA FROM DEPARTMENT OF EDUCATION ANNUAL REPORTS

Division or County Name and Number		Daily Bus Mileage	Total Pupils Transported Daily	Number of Centralized Schools	Number of Buses Operated	Total School Enrolment
(1)		(2)	(3)	(4)	(5)	(6)
Berry Creek	1	575	146	3	9	205
Cardston	2	2,211	957	7	41	2,829
Medicine Hat	4	1,652	1,104	6	51	1,234
Taber	6	2,462	1,578	6	38	2,634
Lethbridge	7	3,048	2,135	14	71	3,178
Acadia	8	2,510	564	6	41	1,013
Sullivan Lake	9	1,293	468	4	25	590
Peace River	10	1,400	1,602	9	48	2,602
Lac Ste Anne	11	3,361	2,009	10	54	2,716
Edson	12	2,707	1,791	8	37	3,634
Rocky Mountain	15	2,016	1,147	6	29	2,048
Neutral Hills	16	1,816	492	4	28	790
Lamont	18	2,944	1,741	7	40	2,339
Vegreville	19	3,263	1,682	7	48	2,386
Camrose	20	4,089	2,447	12	61	2,676
Two Hills	21	3,056	1,539	5	47	2,057
Killam	22	3,080	1,625	9	45	2,207
Stony Plain	23	3,064	2,426	11	56	3,861
Vermilion	25	3,950	1,979	10	70	2,646
MacLeod	28	3,677	950	5	55	2,490
Pincher Creek	29	1,856	702	2	26	1,248
Drumheller	30	2,125	756	6	33	950
Wainwright	32	2,444	992	4	32	1,870
Provost	33	2,210	719	6	31	1,022
Red Deer	35	3,882	2,465	10	58	4,889
Westlock	37	2,850	2,029	12	59	2,681
Foothills	38	2,922	1,278	7	43	1,558
Calgary	41	4,083	1,820	10	59	2,382
Bonnyville	46	3,704	1,744	9	47	2,419
Spirit River	47	2,683	1,513	8	39	1,899

TABLE XIII (Continued)

Division or County Name and Number (1)		Daily Bus Mileage (2)	Total Pupils Transported Daily (3)	Number of Centralized Schools (4)	Number of Buses Operated (5)	Total School Enrolment (6)
High Prairie	48	1,848	1,614	12	43	2,897
Leduc	49	2,904	2,491	11	51	3,816
Fairview	50	1,980	1,024	5	37	1,443
Lac La Biche	51	1,103	1,075	8	27	1,532
Fort Vermilion	52	275	265	5	8	801
East Smoky	54	824	592	3	13	804
Red Deer Valley	55	201	121	4	6	505
Three Hills	60	3,523	1,593	9	61	2,074
Northland	61	172	137	7	5	967
Counties						
Grande Prairie	1	2,442	2,006	10	47	2,539
Vulcan	2	3,968	1,243	8	59	1,983
Ponoka	3	2,286	2,204	6	50	3,378
Newell	4	2,247	1,266	9	48	1,747
Warner	5	2,589	1,007	7	43	2,443
Stettler	6	3,360	1,314	9	56	1,517
Thorhild	7	1,537	1,119	4	23	1,687
Forty Mile	8	3,524	1,103	7	50	1,520
Beaver	9	3,222	1,561	6	50	2,419
Wetaskiwin	10	2,575	1,882	10	44	2,164
Barrhead	11	2,092	1,554	7	37	2,307
Athabasca	12	4,320	2,009	10	64	2,599
Smoky Lake	13	2,090	1,232	6	30	1,655
Lacombe	14	3,035	2,140	8	54	3,598
Sturgeon	15	2,587	2,314	13	55	2,645
Wheatland	16	3,465	1,259	8	48	1,935
Mountain View	17	4,301	2,103	9	61	3,570
Paintearth	18	2,900	992	4	40	1,225
St. Paul	19	3,282	1,911	10	53	1,908
Strathcona	20	2,069	2,274	7	38	4,056

TABLE XIV

ORIGINAL DATA FROM DEPARTMENT OF MUNICIPAL AFFAIRS REPORTS

Division or County Name and Number		Equalized Assessment	Total Resident Population	Total Assessed Acreage	Total Acreage Within Boundaries
(1)		(2)	(3)	(4)	(5)
Berry Creek	1	$ 3,949,371	1,672	292,768	964,231
Cardston	2	11,941,782	5,398	743,303	829,767
Medicine Hat	4	6,637,280	5,211	1,145,983	2,951,443
Taber	6	12,315,950	6,575	696,958	1,045,090
Lethbridge	7	12,586,043	11,624	677,900	705,393
Acadia	8	7,050,955	3,069	577,093	1,442,255
Sullivan Lake	9	4,076,338	2,153	376,918	1,241,379
Peace River	10	8,392,845	7,355	628,971	4,078,466
Lac Ste Anne	11	7,446,338	7,370	652,404	1,416,986
Edson	12	16,353,961	7,574	434,325	6,692,359
Rocky Mountain	15	4,380,386	5,628	489,842	2,551,598
Neutral Hills	16	4,670,031	2,200	385,164	1,268,540
Lamont	18	12,291,083	7,700	582,466	616,895
Vegreville	19	12,782,617	6,742	788,066	844,105
Camrose	20	14,948,145	9,626	820,226	841,546
Two Hills	21	9,203,904	7,114	622,280	671,690
Killam	22	12,471,997	6,697	991,221	1,009,595
Stony Plain	23	21,625,765	11,592	644,509	906,151
Vermilion	25	17,520,165	9,334	1,139,632	1,246,370
MacLeod	28	16,875,537	6,344	1,004,247	1,181,467
Pincher Creek	29	9,161,601	3,109	547,690	714,344
Drumheller	30	6,899,949	2,831	555,662	639,851
Wainwright	32	10,475,926	5,085	756,998	911,826
Provost	33	7,279,795	3,621	727,571	902,321
Red Deer	35	19,010,944	12,830	962,284	1,014,013
Westlock	37	9,409,992	9,557	673,283	1,251,680
Foothills	38	13,255,212	7,902	824,875	824,875
Calgary	41	19,384,299	15,244	1,068,583	2,140,804
Bonnyville	46	4,365,350	12,714	580,690	1,928,907
Spirit River	47	6,497,430	6,964	741,888	2,438,033
High Prairie	48	7,063,496	10,306	607,039	3,055,673

TABLE XIV (Continued)

Division or County Name and Number (1)		Equalized Assessment (2)	Total Resident Population (3)	Total Assessed Acreage (4)	Total Acreage Within Boundaries (5)
Leduc	49	21,976,090	10,755	727,094	876,303
Fairview	50	5,411,837	8,469	836,669	12,847,997
Lac La Biche	51	1,959,120	5,066	267,721	1,833,009
Fort Vermilion	52	379,322	3,256	119,156	15,281,280
East Smoky	54	1,736,697	2,615	161,157	5,335,834
Red Deer Valley	55	962,852	5,502	37,286	42,663
Three Hills	60	14,946,903	7,055	816,303	834,830
Northland	61	603,682	3,594	104,431	40,039,201
Counties					
Grande Prairie	1	9,640,841	8,894	935,171	1,419,615
Vulcan	2	17,886,782	5,242	1,083,552	1,340,400
Ponoka	3	13,892,576	8,611	631,313	804,914
Newell	4	7,811,177	5,943	1,447,508	1,487,252
Warner	5	12,597,889	4,652	914,415	914,415
Stettler	6	10,720,783	6,061	952,304	994,780
Thorhild	7	8,051,085	5,596	418,187	519,451
Forty Mile	8	12,549,901	4,224	1,156,130	1,792,039
Beaver	9	11,670,965	6,883	774,664	901,120
Wetaskiwin	10	10,839,178	9,462	609,721	871,968
Barrhead	11	6,055,254	6,684	507,458	1,475,882
Athabasca	12	6,006,236	8,600	649,948	1,467,736
Smoky Lake	13	5,056,201	5,517	399,619	701,534
Lacombe	14	19,739,341	8,351	679,070	750,310
Sturgeon	15	11,513,268	13,708	491,719	521,756
Wheatland	16	14,914,221	5,582	1,095,608	1,222,520
Mountain View	17	17,723,980	9,273	872,417	930,203
Paintearth	18	7,608,084	3,098	779,595	821,197
St. Paul	19	5,676,240	7,979	628,124	862,872
Strathcona	20	36,209,620	10,987	353,510	378,146

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